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BULLETIN

OF

THE NEW YORK BOTANICAL GARDEN

VOLUME XII, 1922–1924

BULLETIN

OF

The New York Botanical Garden



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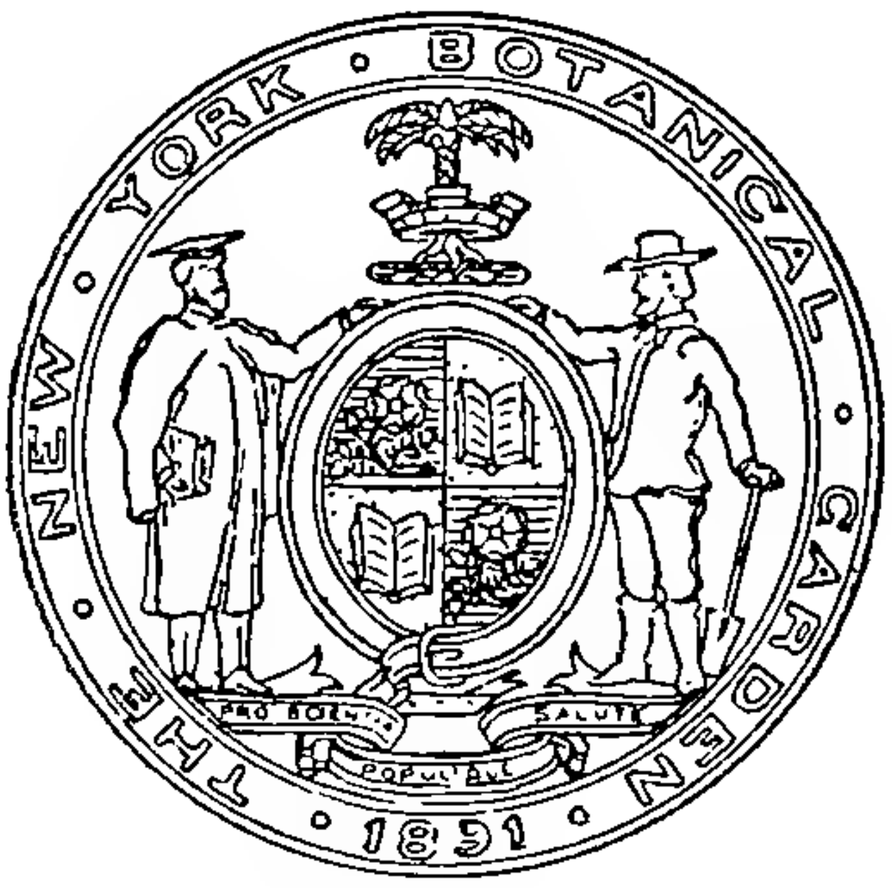
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OF

THE NEW YORK BOTANICAL GARDEN



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BULLETIN
OF
The New York Botanical Garden

Vol. 12 No. 42

REPORT OF THE SECRETARY AND DIRECTOR-IN-CHIEF FOR THE YEAR 1921

(Accepted and ordered printed January 9, 1922.)

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: I have the honor to submit my report for the year ending January 9, 1922.

Much progress has been made in the development of the Garden and in the increase of its collections during the past year, and the maintenance of grounds and buildings has been continued, without special incidents. The beautiful, natural features of the reservation have been conserved without deterioration. Necessary repairs to buildings have partly been accomplished, but considerable work of this kind still needs attention. The construction of additional parts of the path systems as planned has been continued in the southern part of the reservation, especially at and near the Horticultural Garden, and south of the Rose Garden. Construction of the boundary wall and fence was continued along the Southern Boulevard, and the Mansion Approach Entrance, together with some adjoining fencing, was built on the Pelham Parkway. Additional planting was accomplished at many points, especially at the new Fern Garden and the Rock Garden, in the Flower Garden and in the Arboretum; new plantations of

peonies were established and the collections of dahlias and tulips were increased. Large additions were made to the collections of cacti, and the extensive collection of palms was further rearranged.

Lectures to the public on Saturday and Sunday afternoons on a wide range of botanical and horticultural subjects were continued from early spring until late autumn; instruction through docentry was continued with an increasing demand for this service; requests for information about plants and plant products have been answered in increasing numbers; work on the labeling of all collections has been continued. The public educational work of the institution thus continues to expand.

Botanical exploration and collecting of specimens and of plants were accomplished in Florida, Trinidad, French Guiana, British Guiana, and Cuba, and the museums and herbarium and greenhouse collections have been enriched through this work, and important additions to knowledge have been made. The specimens thus obtained have been partly studied and distributed into the permanent collection, and this work is being continued. Especial attention has been given to the study of the flora and plant products of northern South America under our cooperative arrangement with the United States National Museum and the Gray Herbarium of Harvard University.

During the year we have had about 15,000 species and varieties of plants under cultivation within the grounds and in the greenhouses, or wild within the reservation. The library has been increased by nearly 600 bound volumes, and now contains about 30,500 bound volumes. Additions to the museums and herbarium aggregate about 34,275 specimens.

Publications during 1921 include Nos. 40 and 41 of the *Bulletin*, 9 numbers of Volume 22 of the *Journal*, 2 parts of *North American Flora*, 5 parts of Volume 13 of *Mycologia*, 4 parts of *Addisonia*, and 9 numbers of *Contributions*. Our

Bulletin No. 41 containing Dr. Rusby's Guide to the Economic Museum, published April 30th, is a very important contribution to the literature of economic botany.

Plants and Planting

Additions have been made to many of the collections of living plants, both out of doors and under glass; these have been reported from time to time as accessions recorded in our *Journal*.

The collection of cacti was largely increased by plants secured through Dr. J. N. Rose of the United States National Museum and his correspondents in Texas and California, and by Dr. D. T. MacDougal, during the progress of the investigation of the Cactus Family in cooperation with the Carnegie Institution of Washington; also through many fine specimens collected for us by Mr. E. C. Rost in Southern California and Lower California and by Dr. John K. Small in Florida.

The collection of hardy ferns in the new fern garden received important accessions collected at various localities by Dr. E. B. Southwick, who has it in charge, and by Mr. C. A. Weatherby, who sent many plants collected by him in Connecticut, and a few exotic species were obtained from H. A. Dreer & Co., of Philadelphia.

Dr. E. B. Southwick continued the construction of the new rock garden and the assembling of plants for it, and this work will be prosecuted during the coming season.

Through valued gifts of peonies by Mrs. Edward Harding and by Mrs. Charles D. Dickey, new and large plots were planted in the horticultural gardens. Many additions were made to the iris collection, in cooperation with the American Iris Society; the Japanese species were brought together in two plots at the bottom of the slope to the south at the new Iris Garden.

The collection of rose mallows was increased by plants bred by Dr. A. B. Stout, during his experimental work

with the hardy species, and ground has been prepared for a further installation of these plants, remaining in the nursery, during the coming spring.

Through continued cooperation with the General Bulb Growers' Association of Holland and Mr. John Scheepers of New York, the collections of tulips have been continued and augmented. Some 19,000 bulbs received from them were planted in the autumn in the horticultural gardens and about the same number in the court of conservatory range No. 1; about 3,000 bulbs from various sources were planted in the flower-gardens and elsewhere, making a total of about 22,000 bulbs which may be expected to flower in the spring.

Through continued cooperation with Mrs. Mortimer J. Fox, the collection of hardy lilies has been largely increased, providing plants utilized by Dr. Stout in his studies of hybridity. A special plot was prepared and planted in the horticultural gardens, in which a representation of the species was brought together; other bulbs were grown experimentally in the nurseries and others planted in the flower-gardens.

The large and representative collection of dahlias, planted at the railroad station, in charge of Dr. Marshall A. Howe, was expanded, especially through a valuable series of tubers loaned by Judge Josiah Marean; the plants flowered profusely until October 26th when they were killed by frost.

The large and representative collection of palms, now occupying three houses and part of a fourth house of conservatory range No. 1, was regrouped and rearranged, under the direction of Foreman William Becker, and increased by plants brought from the propagating houses. Contingent upon the reglazing of the roof of house No. 1, effected during the summer and autumn, two of the largest palms, which had outgrown the capacity of the house and were breaking glass from the roof with each new leaf formed, were removed and, of necessity, destroyed; several

of the next largest specimens were successfully moved. The collection now contains about 130 species of palms represented by over 500 specimens.

Details of work upon the plant collections will be found in the report of the Head Gardener hereto appended.

Museums and Herbarium

Details of curatorial and investigational work on the museums and herbarium will be found in the report of the Head Curator, hereto appended. Much progress was made in incorporating into the permanent collections specimens held in storage and in the naming, labelling, and distribution of specimens recently obtained through explorations in tropical America. Additional cases obtained through the expenditure of an appropriation from the income of the Sage Fund, provided place for the additional specimens; during this work the greater portion of the herbarium was moved. Nearly all the many thousand unmounted specimens were examined, and selections made from them for sending to other institutions as exchanges. The Local Herbarium, made up of specimens illustrating the wild plants growing naturally within one hundred miles of New York City, was moved from cases in one of the hallways to new cases in one of the other rooms. Mr. Kenneth K. Mackenzie, a member of the corporation, presented a fine new oak table for this room. Much attention has been given to the herbarium of cultivated plants which contains specimens of all species which have been grown and flowered at the Garden, very important for purposes of record.

Supplies required for the museums and herbarium as well as for the library and laboratories have been bought from the income of the Darius Ogden Mills fund.

Library

As shown by the report of the Librarian, hereto appended, the collection of books includes 30,534 bound volumes,

548 volumes having been added during the year, mostly by purchase through the incomes of the Maria DeWitt Jesup Fund, the Fanny R. Bridgham Fund, and the Henry Iden Fund, and by exchanges of our publications for those of other institutions and societies. Book-binding continues to be expensive, and we have a considerable accumulation of unbound volumes and many volumes that require re-binding. An additional card-catalogue case is now required.

Public Instruction and Information

Lectures for the public, on botanical and horticultural topics, have been delivered on Saturday and Sunday afternoons, from early spring until late autumn, using both the museum lecture hall, and the lecture space provided in conservatory range No. 2. The plan of following or otherwise associating these public lectures with demonstrations or descriptions of plants referred to, by guiding the audiences to the collections, on the grounds or in the buildings, has been elaborated and appreciated; some of the lectures have, indeed, taken on the character of such a demonstration only. It appears to be desirable further to develop this type of instruction. The need of a special lecture fund mentioned in previous reports still exists.

Information and instruction of visitors, by members of the staff acting as docents, has been continued throughout the year, with increasing requests for this service. Docents have been made available every week-day afternoon at three o'clock, and at other times when arranged for in advance. Most of this work has been done as in previous years by Mr. Percy Wilson, Associate Curator; Mr. R. S. Williams, Administrative Assistant, Mr. William Becker, Foreman Gardener, and Dr. W. A. Murrill, Supervisor of Public Instruction, but all members of the staff have taken part in it to some extent. The increasing amount of time required for this very important duty, makes it desirable that much of it be concentrated in a docent, with this as his principal occupation, which would relieve other officials for work much needed on the collections or otherwise.

Labelling of all collections has been continued, without change in methods. Our present provision for this important informational work is inadequate, however, owing to the largely increased number of plants and specimens. Additional group-labels have been set up at various places as well as additional direction-signs at points within the grounds, and a new map of the Garden has been printed for posting at entrances and elsewhere and for sale.

Special exhibitions of plants and flowers have been continued in cooperation with the Horticultural Society of New York, and prizes paid from the income of the Henry Iden Fund.

Requests for information by mail continue to be very numerous, and replying to these inquiries requires much time; this work is divided up among the members of the staff.

Details of educational activities will be found in the reports of several staff-members hereto appended.

Exploration and Collecting

Under the cooperative arrangement entered into in 1918 with the United States National Museum and the Gray Herbarium of Harvard University for the investigation of the flora and plant products of northern South America and islands adjacent,* botanical exploration and collecting, and the study of the large collections made, have been continued, resulting in important increase in knowledge, and in extensive and valuable additions to the herbaria and museums of the cooperating institutions. Accompanied and assisted by Mrs. Britton and by Dr. Fred J. Seaver of our staff I continued this work on the island of Trinidad during March and April, 1921,† with the highly valued cooperation of Mr. W. G. Freeman, Director of Agriculture of Trinidad and Tobago, and of other officials of his de-

* See Journ. N. Y. Bot. Gard. **19**: 182–185; Science N. S. **53**: 29, 30.

† See Journ. N. Y. Bot. Gard. **22**: 93–102. 1921.

partment. These collections have been nearly completely studied. Mr. W. E. Broadway, Assistant Botanist of the Trinidad Agricultural Experiment Station, was commissioned, while we were there, to proceed to French Guiana for the purposes of this investigation. His object was successfully accomplished and the important collection made by him* was received, divided among the three institutions, and has been partly studied.

Dr. Henry A. Gleason, our Assistant Director, proceeded to British Guiana in June and made a large collection there which he brought back with him on his return in September, together with many duplicate specimens from the herbarium of the botanical garden at Georgetown, obtained through the kind cooperation of Sir John B. Harrison, Director of Science and Agriculture.† A beginning has been made upon the study of these collections.

Further expeditionary work is planned for 1922 on behalf of this cooperative investigation. Important aid in the study of parts of the collections already made has been obtained from Mr. N. E. Brown, at the Royal Botanic Gardens of Kew, England, and this assistance may be continued. It has become necessary, however, that one of our most trained botanists spend some time at Kew, in continuation of the work I accomplished there in 1920‡ through the kind permission of Sir David Prain, Director, and that a visit be made also to the Jardin des Plantes at Paris for the purposes of this investigation.

Leading the Mulford Biological Expedition, Dr. Henry H. Rusby, Honorary Curator of our Economic Collections, is at present in Bolivia, making large scientific and economic collections. His party reached La Paz, Bolivia, in June, 1921, and proceeded down the eastern side of the Andes. We have received several communications from him reporting successful progress, and some of his collections have

* See Journ. N. Y. Bot. Gard. **22**: 177–183. 1921.
† See Journ. N. Y. Bot. Gard. **22**: 161–168. 1921.
‡ See Journ. N. Y. Bot. Gard. **21**: 197–208. 1920.

also been received; these cannot fail to add greatly to knowledge of the flora and plant products of Bolivia, a country visited by Dr. Rusby in 1885–1886, at which time he brought out many thousand specimens, a complete set of which are preserved in the herbarium of Columbia University, deposited at the New York Botanical Garden.

Dr. John K. Small, Head Curator, through continued and highly appreciated aid from Mr. Charles Deering, has made further collections in many parts of Florida.

We have joined with the Smithsonian Institution and other organizations in commissioning Mr. Paul C. Standley, of the United States National Museum, to visit Salvador, Central America, for botanical collecting in a little known region.

Roads, Paths, Grading, Drainage, and Water Supply

The driveways have been maintained as in previous years by the Park Department, under the provisions of the Garden's charter, and we highly appreciate the valued cooperation of the Honorable Joseph P. Hennessy, Commissioner of Parks of the Borough of The Bronx, and his staff in this work, and in many other matters. The road from the rose garden to the stable plaza, which remained uncompleted at the time of my last annual report, is yet in the same unfinished condition, awaiting available city funds for its surfacing and lighting. The embankment, where this road crosses the valley of the Long Lake, has been widened and strengthened by earth dumped there by contractors, without cost. It will be remembered that this portion of the driveway system is planned to take the place of the old, narrow and dangerous road leading north from the mansion, on which there have already been several accidents, and others may be anticipated at any time. It has been necessary to close the old road at times when ice made the surface too smooth for safety. The opening of the new road will be a great relief from anxiety and will bring a now little visited part of Bronx Park into use.

The path system has been cared for by garden laborers in charge of Foreman Gardener John Finley. Considerable resurfacing was accomplished and we built a number of culverts to secure more complete surface drainage. Additional parts of the path system built and opened during the year aggregate about 1700 lineal feet, and about 900 feet were partly constructed. The paths needed along the Bronx River leading northward from the Linnaean Bridge, mentioned in previous annual reports, still await construction.

Much grading and drainage were required during the building of paths. The water-supply system has not been changed, except for replacing rusted pipes at the stable and leading water to the rock garden.

Details of these works will be found in the report of the Superintendent of Buildings and Grounds hereto appended.

Boundary Fences and Entrances

In continuation of the boundary fence partly constructed last year along the Southern Boulevard, about 200 running feet of this fence were built during 1921 and the iron railing for about 500 feet of it, uncompleted in 1920, was purchased and set in place, the total length of fence completed along this boulevard, during the two years, including the Horticultural Garden Entrance, being 741 feet; there remains a length southward to Pelham Avenue, unfenced, of 668 feet. The work accomplished in 1921 was made possible by an appropriation from the income of the Russell Sage and Maria Olivia Sage Memorial Fund; the entrance and part of the fencing built in 1920 were obtained through a bequest of $5,000 by Mrs. Mary J. Kingsland.*

A bequest of $5,000 by Mrs. Louisa Combe amounting, with interest, to $5466.38, was expended during 1921, after appropriation by the Board of Managers, for con-

*See Journ. N. Y. Bot. Gard. **22**: 15; 138, 139. 1921.

struction of the Mansion Approach Entrance, with adjoining fencing on the Pelham Parkway, and about 100 feet of fencing was built here also through the income of the Sage Fund; including this entrance, 234 feet of the boundary construction was accomplished here. Altogether, including the two entrances, the boundary has been thus protected and ornamented during 1920 and 1921 for a length of 975 feet, out of the estimated length of about 5,000 feet required, leaving about 4,000 feet to be provided for. The continuation of this work is very important, and it is hoped, that by means of the Special Development Fund of 1922, to be raised by subscription, we shall be able to build several hundred feet more fence along Pelham Parkway and that funds for one of the driveway entrances may also be obtained as a gift. A bequest of Mrs. Emma Chambers Jones, $1,000, has been appropriated by the Managers for the piers of one of the path entrances.

Buildings and Bridges

No new buildings were constructed during the year; much necessary repair work was accomplished and this is recorded in detail in the report of the Superintendent of Buildings and Grounds hereto appended. Under a contract awarded by the Commissioners of Parks the roof of the great palm house at conservatory range No. 1 was reglazed, with the exception of the upper dome, and all wooden rafters and bars were replaced; except for minor repairs from time to time this roof has lasted since it was built in the year 1900. The roofs of houses 4 and 13 of consevatory range No. 1 need similar renovation. Through the work of our own painters and glaziers the roofs of the other houses of this range have been kept in good order and require only ordinary attention, although much painting both inside and out should be accomplished this year as well as some external painting at conservatory range No. 2. Repairs at the museum building included waterproofing

the roof and interior painting of walls; ordinary repairs were accomplished at the smaller buildings, including an almost complete renovation of the interior of the house containing the public comfort station south of the Mansion. At the Mansion two rooms were repainted and certain collections of the Bronx Society of Arts and Sciences which have been housed in the northeastern room on the main floor have been moved to the room just above it; the main floor room is being developed as a gallery in cooperation with the Wild Flower Preservation Society of America for the illustration by paintings and otherwise of wild plants needing protection.

Special Development Fund of 1921

The subscription fund for the development and improvement of grounds and collections, originated by the authority of the Board of Managers in 1920, was continued into 1921, and the following contributions were made to it by members of the Garden:

Dr. Robert Abbe	$25
Mr. Fritz Achelis	25
Mr. Edward D. Adams	100
Mrs. George A. Armour	25
Mrs. Robert Bacon	50
Mr. George F. Baker	100
Mr. Henry deForest Baldwin	25
Mr. Eugene P. Bicknell	25
Miss Elizabeth Billings	25
Mr. George Blumenthal	25
Mr. George S. Brewster	100
Dr. N. L. Britton	1,000
Mr. C. A. Coffin	50
Mr. James W. Cromwell	200
Mr. Charles Deering	250
Mr. Cleveland H. Dodge	100
Miss Katharine Du Bois	50
Mrs. Coleman du Pont	15
Mr. Samuel W. Fairchild	25
Mr. Henry W. de Forest	250
Dr. Robert W. de Forest	50
Mr. Daniel Guggenheim	250

Mr. Murry Guggenheim	250
Mr. Edward S. Harkness	500
Mrs. E. H. Harriman	100
Mr. T. A. Havemeyer	50
Miss Caroline C. Haynes	25
Mr. Bernhard Hoffmann	25
Mr. E. C. Jameson	25
Mrs. Walter Jennings	25
Mrs. Delancey Kane	100
Mrs. John Innes Kane	100
Mrs. John S. Kennedy	15
Mrs. Gustav E. Kissel	25
Mr. Edward V. Z. Lane	100
Mr. A. R. Ledoux	10
Mr. G. Levor	25
Mr. Adolph Lewisohn	100
Mrs. V. Everit Macy	25
Mr. Emerson McMillin	100
Mr. J. P. Morgan	250
Dr. L. R. Morris	100
Mr. Charles Lathrop Pack	100
Mrs. George W. Perkins	100
Mr. W. H. Perkins	50
Mr. F. R. Pierson	25
Mrs. Harold Irving Pratt	100
Mr. William Rockefeller	250
Mrs. James Roosevelt	25
Mrs. Herbert L. Satterlee	25
Mr. Mortimer L. Schiff	100
Mr. Leon Schinasi	1,000
Mrs. James A. Scrymser	500
Mr. A. R. Shattuck	25
Mrs. Benson B. Sloan	25
Mr. William Sloane	50
Total	$7,690

Through its expenditure (a small balance remaining) the new iris garden and its path connections to the north, east and south were completed; the new hardy fern garden was completed and work was continued upon the rock garden; further additions were made to the collection of hardy lilies, by completing the expenditure of the contribution made by Mrs. Fox in 1920; the path-system was extended along the driveway opposite the collection of rose-mallows, and partly built northward towards the

bridge spanning the gorge of the Bronx River; a much needed flight of stone steps was built with a path approach from the river path to the foot of the cherry garden valley through the expenditure of Mr. Schinasi's gift; a large unsightly stagnant pond at the site of the new lilac garden was filled, drained and the surface here nearly completely regulated and graded; the rose garden and the new lilac garden were connected by a path built through the rocky gorge between them; a marshy tract west of the Bronx River along Pelham Avenue was partly filled with earth and may be regulated and graded in the spring; minor improvements were effected elsewhere within the grounds.

The Special Development Fund for 1922 has been designated by the Board of Managers to be used for the development of the southern part of the garden reservation bordering Pelham Parkway, under the auspices of a committee of the Women's Auxiliary in cooperation with a committee of the Scientific Directors; it is desired that about $15,000 be subscribed.

Administrative

The Garden suffered a great loss on July 15th through the death of Mr. George V. Nash, who had been Head Gardener for a long series of years;* the position was filled by the promotion of Mr. Kenneth R. Boynton, Supervisor of Gardening Instruction.

Dr. Francis W. Pennell, who had served as an Associate Curator for about seven years, resigned in August to accept the curatorship of Botany in the Academy of Natural Sciences of Philadelphia;† the position was filled by the appointment of Mr. James A. Crawford, of the Buffalo Botanical Garden.

Dr. Arthur Hollick, formerly one of our curators, more recently Director of the Staten Island Institute of Arts

* See Journ. N. Y. Bot. Gard. **21**: 145–148. 1921.

† See Journ. N. Y. Bot. Gard. **21**: 171, 172. 1921.

and Sciences and an official of the United States Geological Survey, returned to the Garden in July, as Palaeobotanist, in charge of the large collections of fossil plants.

Reports Appended

I append reports made by Dr. Gleason, Assistant Director; by Dr. Small, Head Curator; by Dr. Murrill, Supervisor of Public Instruction; by Mr. Boynton, Head Gardener; by Dr. Stout, Director of the Laboratories; by Mr. Corbett, Superintendent of Buildings and Grounds; by Dr. Barnhart, Bibliographer; by Miss Harlow, Librarian; by Dr. Hollick, Palaeobotanist; by Mrs. Britton, Honorary Curator of Mosses; and the schedule of expenditures by Mr. Groesbeck, Bookkeeper.

Respectfully submitted,
N. L. BRITTON,
Director-in-Chief.

REPORT OF THE FIRST ASSISTANT AND ASSISTANT DIRECTOR

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit herewith my annual report for the year 1921.

As in the previous year, the greater part of my time has been devoted to the ordinary routine of administrative detail. I had entire charge o the administration during your absence in Trinidad early in the year, and am again pleased to record the hearty cooperation of our staff and employees.

The editorship of the *Journal* was transferred to Mr. R. S. Williams, Administrative Assistant, at the beginning of the year. Volume 22, for 1921, contains 230 pages and 13 full-page plates. The high cost of printing has again compelled the strict limitation of its size and has consequently impaired its usefulness. The *Journal* has also been hampered by vexatious delays in publication, caused by unsettled conditions in the printing trade and apparently

entirely beyond our control. It is hoped that 1922 will see an improvement in punctuality and a decrease in cost.

Addisonia and *Mycologia* have appeared as usual throughout the year.

Bulletin 40, the annual report for 1920, was published Sep. 10, containing 104 pages and completing volume 10. *Bulletin* 41, constituting volume 11 and containing 318 pages, appeared April 30. This number is devoted to Dr. Rusby's careful and detailed catalog of the economic museum and has received much favorable criticism.

During the year 9 numbers of the *Contributions* have been published, aggregating 170 pages, 16 plates, and several figures in the text, as follows:

225. Descriptions of Cuban plants new to science, by Dr. N. L. Britton.

226. Some plants from tropical sea gardens, by Dr. Marshall A. Howe.

228. A graft-chimera in the apple, by Dr. A. B. Stout.

229. A botanical excursion to the Big Cypress, by Dr. John K. Small.

230. "*Veronica*" in North and South America, by Dr. Francis W. Pennell.

231. Types of flowers and intersexes in grapes with reference to fruit development, by Dr. A. B. Stout.

232. Notes on Rosaceae—XIII, by Dr. P. A. Rydberg.

233. A rearrangement of the Bolivian species of *Centropogon* and *Siphocampylus*, by Dr. H. A. Gleason.

234. Sterility and fertility in *Hemerocallis*, by Dr. A. B. Stout.

During the summer the local herbarium was transferred to the unoccupied portion of the room used for my office, where it is much more easily accessible to students of the local flora.

On June 2 I sailed for British Guiana on a botanical collecting trip, returning Sep. 6. The narrative of this trip has already appeared in the *Journal* (**22:** 161–168). The chief scientific results have been the establishment of

scientific relations with the Department of Science and Agriculture of British Guiana, the employment of native collectors continuing work in the field, the discovery of several undescribed species, and the addition of some two thousand numbers to our collections.

Previous to my departure, my personal research was devoted chiefly to a continuation of the work on certain genera of Lobeliaceae. Since my return I have been occupied with the organization of the South American collections. Throughout the year I have served on the editorial board of *Botanical Abstracts* and as a director of the American Iris Society.

Respectfully submitted,

H. A. GLEASON,
Assistant Director.

REFORT OF THE HEAD CURATOR OF THE MUSEUMS AND HERBARIUM

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit herewith my report as Head Curator of the Museums and Herbarium for the year 1921.

The collections under my supervision were conserved and developed as in former years.

The specimens brought together during the year represent a very wide geographic range. The material received was accessioned in installments in numbers of the *Journal*. The accession lists there recorded maybe summarized as follows:

Specimens received through	gifts and purchases	5,003
" " "	exchanges	15,226
" " "	exploration	14,046

Thus an aggregate of 34,275 specimens was added to the permanent and duplicate resources of our public exhibits and research collections. The value of the specimens received as gifts is estimated at $136.30. About 17,500 duplicate specimens were sent to other institutions and individuals as exchanges. Other specimens or credits have been received in return.

Museums

Two exhibition cases were added to the museum equipment and miscellaneous specimens were interpolated in the several divisions of the museums.

Economic Museum

The general rearrangement of this exhibit and the interpolation of specimens were completed in the first part of the year. The labelling of the newly added specimens was continued.

Systematic Museum

The four divisions comprising the museum were maintained as heretofore:

The Synoptic Collection was increased by the addition of a few specimens in the lower and the higher plant groups. The two new museum cases referred to above were devoted to exhibiting the flowers and fruits of the cacti represented in the second volume of "The Cactaceae."

The Local Flora was enlarged by the interpolation of specimens or illustrations in the lower groups.

The Microscope Exhibit was varied by the changing of some of the specimens.

The Plant Picture Exhibit remained unchanged.

Fossil Plant Museum

The palaeontological collections were enriched by the addition of fossil plants from the West Indies, Trinidad, and Alaska.

The wall cases of the public exhibit were renovated and the specimens relabelled.

Herbarium

An aggregate of 34,032 specimens were received during the year. Some miscellaneous specimens came from the Old World. The great bulk of the additions, however,

were derived from America, particularly from regions upon which the active research work of the Garden is focused, viz., the western states, Florida, Mexico, Central America, Panama, West Indies, and northern South America. A valuable addition was a large representation of the flora of Juan Fernandez.

Specimens selected from those received during the year and from those held over from former years, totalling 31,000, were mounted and incorporated in the permanent collections. This increase represents about 15,310 herbarium sheets. Specimens received for the Columbia University herbarium were mounted and incorporated in that collection, while the local flora herbarium was increased by the addition of selected specimens gathered within a radius of one hundred miles of the City of New York.

Maintenance and Investigations

The curatorial work was executed by the several curators and associate curators, some of whom have also participated in other activities approved by yourself, and all of whom have prosecuted some line or lines of investigation connected with the activities of the Garden.

Dr. P. A. Rydberg, Curator, was, as in former years, in charge of the phanerogamic part of the herbarium. About six weeks were devoted to finishing manuscript prepared for *North American Flora* during the preceding year and to studies on the North American tuber-bearing specimens of the genus *Solanum*. During the remainder of the year he was occupied most of the time with purely mechanical work, such as moving the herbarium into the new cases, fumigation, and sorting unmounted herbarium material. Dr. Rydberg printed two papers written in former years, viz., "Rosaceae, XIII" and "Roses of the Columbia Regions."

Dr. Marshall A. Howe, Curator, continued to have special charge of the collections of Algae and Hepaticae.

His personal investigations included studies of collections of algae made by himself in Porto Rico, and by others in Alaska, Hudson Bay, and China, and of fossil algae from Trinidad. As during the three years preceding, he has given considerable time and attention to the improvement and care of the Garden's collection of living dahlias, which now includes about five hundred varieties and has developed into one of the most attractive and popular of the Garden's floral displays. He has continued to act as associate editor of the publications of the Torrey Botanical Club and has served as the Club's delegate to the Council of the New York Academy of Sciences, and during the latter part of the year he also acted as the club's secretary. During the year also he has served as a member of the Board of Control of *Botanical Abstracts*. Dr. Howe has given three lectures in the Saturday afternoon courses and several other lectures in New York City and vicinity.

Dr. Fred J. Seaver, Curator, has continued in charge of the collections of lower fungi, the higher fungi being looked after by Dr. W. A. Murrill. February 21 toApril 25 was spent in Trinidad by Dr. Seaver in company with yourself, his time being entirely devoted to the collection of fungi. Six hundred and forty seven collection numbers were made, which are capable of division into more than two thousand specimens for use as exchanges. One hundred and fifty specimens of tropical rusts have already been obtained from Dr. E. W. D. Holway in exchange for an equal number of Trinidad rusts and other exchanges are being negotiated. In addition, one hundred and sixty specimens have been sent to Dr. J. C. Arthur in return for his services in making determinations, a list of which is ready for publication. Work is progressing on the study and determination of other groups of fungi, especially ascomycetes, many of which are undescribed, or represent South American species not represented in our collections. Manuscript on the genus *Phyllosticta* for *North American Flora* is in type and one paper was published during the

year. Two lectures were given in connection with the regular Saturday afternoon course at the Garden. The regular routine was maintained, and some time was devoted to the work connected with injurious insects and fungi.

Mr. Percy Wilson, Associate Curator, continued his studies of tropical American plants, and made progress in the preparation of manuscript for a flora of Porto Rico and the American Virgin Islands, which is being written in cooperation with yourself. Many miscellaneous collections, as well as individual specimens of local flowering plants, were determined by Mr. Wilson and considerable time was devoted to preparing duplicate material for distribution to other institutions. Over 3100 students from both public and private institutions received his personal instruction on the days when he acted as docent.

Dr. F. W. Pennell, Associate Curator, from January to September, inclusive, continued his studies of Scrophulariaceae. He published one paper on "Veronica in North and South America;" but otherwise the nine months of his stay at the Garden were mainly consumed in finishing certain studies preliminary to his departure for the purpose of assuming charge of the herbarium of the Academy of Natural Sciences of Philadelphia. Two chief tasks were the identification of nearly all our unnamed specimens of the Figwort family and the indication on our sheets of all American types and isotypes. He also prepared two papers dealing with some overlooked genera and species of Rafinesque, the latter only being limited to Scrophulariaceae. Of course during the year much time was given to necessary plant-determination and to aiding in the purely mechanical herbarium work.

Mr. James A. Crawford, Associate Curator, since the first of October, devoted most of his time to aiding Dr. Gleason in connection with the plant collection he obtained in British Guiana.

Dr. H. H. Rusby, Honorary Curator of the Economic Collections, developed the Economic Museum. (See his report.)

Mrs. N. L. Britton, Honorary Curator of Mosses, developed the moss herbarium. (See her report).

Dr. Arthur Hollick, Palaeobotanist, from July to December inclusive, developed the fossil plant museum. (See his report.)

The writer, besides curatorial routine, wrote articles for the *Journal* and *Addisonia*, several of which have already been printed in those publications. He continued incidental studies in the flora and the phytogeography of the eastern United States. These studies were supplemented by two week-end excursions to the mountains of Pennsylvania and the Coastal Plain of Maryland for the purpose of observing the box-huckleberry and for gathering specimens of that shrub for growing in the Garden. He devoted several weeks in the spring and the winter to further exploration in Florida covering territory from the Saint Mary's River to Key West and to studies in the reservations of Mr. Charles Deering in southern Florida, where special plantations and plantings are being developed for aiding in certain investigations regarding native plants, such as zamias, palms, orchids, wild peppers, and cacti. Aside from general collecting in the field, collections were made from special sand-dune formations in the peninsula, certain Florida Keys, and the shell-middens and burial-mounds of the Florida aborigines.

Respectfully submitted,

JOHN K. SMALL,

Head Curator of the Museums and Herbarium

REPORT OF THE SUPERVISOR OF PUBLIC INSTRUCTION

DR. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1921.

The lecture courses were still further extended during the year and instruction by correspondence, interviews, walks, etc., was given freely to all who applied.

Lectures

Fifty-four illustrated public lectures on botanical and horticultural subjects were given in the museum building on Saturday and Sunday afternoons from April 30 to October 30 inclusive, the titles of which were published in the *Journal.* Mr. Boynton was substituted for Mr. Nash on July 30 and August 20. Dr. Howe and Dr. Pennell exchanged dates on August 6 and August 13. Members of the garden staff gave 35 of the lectures and the remaining 19 were by outsiders. The attendance on Saturdays and Sundays averaged 63 for the 36 spring and summer lectures and 120 for the 18 autumn lectures. The maximun attendance on Sunday was 219 on October 23, at the lecture by Dr. Murrill, and the maximum attendance on Saturday was 382, at the lecture given by Dr. Howe on September 24. The general average for all the public lectures in the museum building for the season was 81.

In March, April, and November, two courses of six and four lectures, as published in the *Journal*, were given in the central display greenhouse of conservatory range 2. All the speakers, except one, were from the garden staff. Dr. Murrill was substituted for Dr. Rusby on March 20. The attendance was much better than last year, reaching a maximum of 85 on November 6 and averaging 52 for nine of the lectures, the other day being decidedly stormy.

A short course of lectures to members only was also given in conservatory range 2 late in the fall but the attendance was not very encouraging. A list of this course was published in the *Journal.*

School Lectures and Demonstrations

Several classes in biology from various public high schools have visited the garden for the study of living plants and museum collections and for lectures in our lecture hall. These have been under the general direction of the school teachers, guided by myself and assisted by various members of the garden staff.

Docentry

Many special appointments were made in this department, in addition to the regular schedule, so that fully as many, if not more, persons visited the grounds under guidance of members of the staff than during any previous year. Parties of Girl Scouts were taken out by Mr. Wilson every Saturday afternoon in May, following a preliminary walk on April 30, and at intervals during the summer and autumn groups of Girl Scouts and Biology pupils from the various high schools were in evidence.

Dr. Van Evrie Kilpatrick visited the Garden on Saturday, May 21, with a number of teachers from various parts of the city and was shown exhibits of special interest in connection with nature-study work. On the afternoon of July 13, a group of about sixty students from the Columbia University Summer Session visited the Garden under the leadership of Mr. L. A. Crawford, assistant to the director of the Summer Session. The party was met at the Elevated Railway Station by members of the garden staff and escorted through the grounds.

Meetings

The Brooklyn Institute held a field meeting at the Garden on May 14 for the study of trees. Fifty members of the Woman's Municipal League, including the president, Mrs. Frederick C. Hodgdon, and other officers, visited the Garden on the afternoon of April 27 and were guided through portions of the grounds and buildings. Tea was served at the Mansion under the supervision of Mrs. M. G. Starrett, who planned the excursion. The New York Bird and Tree Club met Saturday, May 28, at the Garden, taking their luncheon at the Mansion. The special object of their visit was a study of trees.

Floral Exhibitions

The Horticultural Society of New York, in cooperation with the New York Botanical Garden, held exhibitions

of flowers in the museum building on the dates given below. The collections of irises, peonies, roses, dahlias, etc., on the grounds also attracted large crowds of people.

May 14, 15. Exhibition of Flowers.
August 20, 21. Exhibition of Gladioli.
September 24, 25. Exhibition of Dahlias.

Personal Investigations

Lectures, editorial work, correspondence, docentry, and other forms of public instruction have allowed very little opportunity for strictly scientific work. Correspondence, both general and mycological, has been unusually heavy. Editorial work on *Mycologia* was continued as usual, and the "Guide to the Economic Museum" was published April 30. Two main articles on resupinate polypores and several shorter articles on various subjects were prepared for *Mycologia*. Considerable field-work was done at Yama Farms, in the Southern Catskills. Several new lectures included in the sixteen delivered by me, were prepared for the various Garden courses, a list of which will be found in the *Journal* for 1921.

Respectfully submitted,
W. A. MURRILL,
Supervisor of Public Instruction.

REPORT OF THE HEAD GARDENER

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to present herewith my report for the year 1921.

Horticultural Operations

The planting and care of the plantations was carried on under the supervision of Messrs. John Finley and H. W. Becker, foreman gardeners for the outside and inside plantations respectively, with a force of 29 gardeners, 14 laborers, and 1 apprentice gardener.

In addition to the regular systematic plantings and the large collections of tulips, gladiolus, etc., which were cared for as usual, special plantings were made as follows: 80 small evergreen trees were planted on either side of the Rose Garden steps and 9 yews in front of them; 9 yews were planted back of the lily bed at the Horticultural Garden; 4 peony beds were made and about 120 plants set out as the nucleus of the collection; additional iris, mallow, and variegated plants were provided for; one new bed was made at the south end of the Horticultural Garden for the collection of narcissi. The latter were planted and mulched in the autumn. One new bed was provided for the collection of dahlias given by Judge Marean. In the flower beds near conservatory range 1 shrubs, evergreens, and perennials were replanted and rearranged and 70 lilacs were planted in the lilac garden. Some of these were taken from the Havemeyer collection at the foot of the Museum approach, which was rearranged at the same time.

Systematic Plantations

HERBACEOUS GROUNDS. The herbaceous collections now comprise about 3,500 species and varieties in the nurseries, herbaceous grounds, and flower beds. The greatest additions have been made to the collections of this type in the work on the fern and rock gardens, which have been under the care of Dr. E. B. Southwick, in addition to the regular herbaceous grounds.

WOODY COLLECTIONS. In the fruticetum, salicetum, arboretum, pinetum, and viticetum the collections remain about the same as last year, with the exception of the addition of 20 poplars and willows to the arboretum and salicetum and of 120 nut trees to the arboretum and nursery.

CONSERVATORIES. The collections under glass have representatives of about 9,000 species and varieties of plants, numbering some 21,600 individuals.

Range 1. During the past year two of our largest palms have been taken down and the whole of house 1 rearranged. Five of the largest specimens were planted out in rockery foundations and the great bamboo group was reduced and moved to house 13. The cool-house plants were removed from house 14 and it is now entirely devoted to specimens of palms and panama-hat plants. House 7 has been supplemented with additional collections of *Echinocereus* and *Echinocactus* from the study collection at the propagating house. This range now contains 8,300 plants.

Range 2. This range now houses collections of orchids, bromeliads, ferns, cycads, and cool-house plants to the number of 8,500. The central display house, in addition to its annual display of acacias and other flowering plants, has exhibited at different times during the year 2,000 plants in full flower, grown especially in this range for exhibition purposes, and 1,000 orchid plants have been displayed in another house.

Propagating Houses and Nurseries. Here are now located 4,800 plants including the study collection of cacti, cuttings, propagating stock and young plants ready for transfer to conservatories.

Miscellaneous Collections

Rose Garden. The winter losses among the roses were replaced by some new plants, several weak varieties being discarded in favor of some dwarf polyantha and hybrid perpetual types.

Dahlia collection. The principal addition here of 50 new kinds by Judge Josiah T. Marean, and other gifts, has brought the number of dahlia varieties up to 502, 824 plants being grown this year, under the direction of Dr. Marshall A. Howe.

Chrysanthemum collection. The hardy chrysanthemum bed this year comprised 642 plants of 66 varieties, mostly old varieties of last year's collection.

Gladiolus collection. Some 15,000 gladiolus bulbs were planted in 8 beds of the Horticultural Gardens, including 207 distinct varieties, 20 of which were new to our collection. A. E. Kunderd, of Goshen, Indiana, and John Lewis Childs, Inc. of Flowerfield, N. Y., replenished the displays of their varieties by gifts of 8,000 and 425 bulbs respectively.

Canna Collections. The cannas this year numbered 1300, in 70 varieties, including a new variety, Statue of Liberty, the gift of the Conard and Jones Company, of West Grove, Pa.

Iris Garden. The Iris garden now contains 773 varieties, 2200 plants, filling 15 beds, including 2 new ones made this year. Over last year we have an increase of about 200 varieties and 700 plants.

Lily Garden. Some 250 bulbs were added to the Lily collection, making about 800 plants, of about 21 kinds, given by Mrs. Mortimer J. Fox.

Variegated Plant Collection. No changes were made in this collection, which contains 718 plants of 66 kinds.

Collection of Tulips. Through the interest of Mr. John Scheepers, the horticultural gardens, conservatory court beds, and the fountain beds were planted this fall with 18,700 tulip bulbs given to the Garden by the Bulb Growers' Society of Holland. Of these one half were planted in the Horticultural Gardens and one half in the conservatory court and fountain beds. This gift collection contains varieties as follows: 75 early single varieties, 45 Darwins, 23 breeders, 24 Cottage, and 7 early double varieties. Some 3,000 bulbs of our old collections were planted in the conservatory flower beds.

Peony Collection. The new collection of peonies instituted this year contains 120 plants, 50 varieties given by Mrs. Edward Harding and 70 plants by Mrs. Charles Dickey.

Narcissus Collection. 900 plants of Narcissus King Alfred, a magnificent large yellow, given by Messrs. Eddy and De Wreede, form the new narcissus collection,

located in a large bed under the rocks in the southern portion of the Horticultural Gardens.

Mallow Collections. Some gaps in this group were filled in with plants from Dr. Stout's experimental plats, making a collection of about 540 plants in all.

Fern Garden. The collection of ferns, south of the Herbaceous Grounds has been increased by some 8,000 plants collected by Dr. E. B. Southwick in their native haunts, and by Mr. C. A. Weatherby and others.

Rock Garden. This collection, through the efforts of Dr. Southwick, who has it in charge, now numbers about 2,500 plants, only the eastern side of the garden being planted as yet.

The white and red pine, memorial Douglas spruce, rhododendron, aquatic, and other miscellaneous collections remain the same as last year.

Labeling, Recording, and Herbarium

The work has been in charge of Mr. John Hartling, Head Gardener's Assistant, with a label boy part of the time. A total of 4,767 labels and 97 family signs have been prepared.

Accession numbers 49,194 to 50,441 have been recorded, making a total of 1,247 accessions for the year. The number of packets of seeds received was 961: by gift, 37; by purchase, 239; by exchange, 672; by collection, 13. The total number of plants received was 24,461: by gift, 20,934, including 18,700 tulip bulbs from the General Bulb Growers' Society of Haarlem, Holland, and 900 narcissus bulbs from Messrs. Eddy and De Wreede; by exchange, 840; by purchase, 1963; by collection, 337; from seed from various sources, 387. The herbarium of cultivated plants has been increased by 200 specimens.

The whole collection, including the plants native to the tract, now comprises approximately 240 families, 2,000 genera, and 15,000 species and varieties.

Investigations and Lectures

I have given two lectures in the regular courses which were scheduled for the late Mr. George V. Nash, and two lectures in the special courses at conservatory range 2. I have also assumed the curatorial work of the cultivated collections and am now engaged in a preliminary checking up of them.

Respectfully submitted,
KENNETH R. BOYNTON,
Head Gardener.

REPORT OF THE DIRECTOR OF THE LABORATORIES

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1921.

General Matters

The laboratories, experimental greenhouse, and breeding plots have been continued during the past year without increase of space or expense over the maintenance of the previous year. The routine duties incident to my position have been performed. Miss Hester M. Rusk has continued as Assistant in the laboratories, rendering efficient assistance in the investigations in progress and in the performance of routine duties.

Personal Investigations

The present year concludes ten years of my association as a member with the staff of the New York Botanical Garden. During this time my research has chiefly been directed to experimental studies of phenomena of sterility and fertility, and especially during the past four years there has been in mind a very definite program for research. In general this plan aims first to investigate all the various types of sterility in plants, and secondly to apply the knowledge thus gained to the problems of fruit and seed production in important economic plants and to the breeding

of such plants. Special investigations are also being made of the phenomena of bud variation and the transmission through seed and bud propagation of infectious and physiological types of chlorosis.

During the past year the investigations in progress at the Garden have included studies of *Hemerocallis* (several species), *Cleome spinosa*, *Lythrum Salicaria*, and varieties of the Irish potato in outdoor plantings; and of *Plantago lanceolata*, several sorts of cultivated *Pelargonium*, two species of *Brassica*, and one of *Piaropus* in a greenhouse. *Coleus* and species of *Lilium* has been grown both indoor and outdoor.

An extensive study of the various species of *Lilium* is now well under way. Thirty-five recognized species have now been assembled and it is planned to secure as many others as is possible. These are being studied to obtain further data regarding taxonomic relationships, sterilities, and the best methods of propagation and culture. They are also being bred and hybridized for the possible production of new varieties. Mrs. Mortimer J. Fox is associated with us in prosecuting these studies and it is due to her financial support that the purchase of bulbs has been possible.

A beginning has been made in the experimental study of the factors determining the flowering of bulb plants, but this research has been delayed from lack of greenhouse facilities. It has, however, been determined that species of *Narcissus* and Hyacinth exhibit physiological incompatibilities in fertilization, a condition which, I believe, has never been previously recognized in these plants.

I wish to extend as widely and as rapidly as possible the study of phenomena of sterility to numerous species not investigated to date. Additional space for culture in greenhouses would greatly facilitate this study. At present I am using the same amount of space in the greenhouses that was assigned to my use 10 years ago.

A welcome opportunity to extend the studies of sterility and fertility to economic plants grown on a large scale has come through cooperation with the State Experiment Station at Geneva, N. Y., in studies of the grape, and with the Bureau of Plant Industry in studies of the Irish potato. Of the work with grapes, I have recently submitted a report which has been published in the *Journal of the New York Botanical Garden.*

The successful breeding of the Irish potato from seed is rather uncertain because its sterilities are not well understood. The recent and rapid spread of various physiological diseases threaten seriously to limit the growing of the standard varieties of today. Breeding from seed for resistant varieties must, it seems, be prosecuted with vigor. I have been investigating this plant for several years and last summer I spent three weeks at Presque Isle, Maine, cooperating with Professor William Stuart and Dr. C. F. Clark of the Bureau of Plant Industry in a general survey of varieties with reference to sterilities. In the plots at the Presque Isle Station, covering more than 40 acres, 112 varieties were represented and three wild species of tuber-bearing solanums were being grown.

Three types of sterility are present in these solanums, the study of which offers a most interesting and profitable investigation. The results already obtained, and the unusual opportunities to coordinate research in these studies of grapes and of the Irish potato are of such promise that it is highly desirable that these cooperative studies be continued.

Registered Students

The following persons have been duly registered for research at the Garden during the year.

Findley, Hugh.	Fertility and Sterility in *Abutilon*.
Glover, Clifford C.	Taxonomy of the *Caprifoliaceae*.
Hamanaka, Kooshin.	Genetics.
Hastings, George. T.	Ecology. Taxonomy.
Johnson, Alice M.	Sterility in *Piaropus*.
Lanfear, Mrs. L. H.	Genetics. Cytology.
Smith, Edna L.	Taxonomy. Ecology.
Stevenson, Mrs. Florence.	Variegation in *Farfugium*.

Two of the above named, Mr. Findley and Mrs. Stevenson have during the year completed requirements for the degree of M. A.

Prof. L. O. Overholts, of Pennsylvania State College, was the recipient of a scholarship during part of the month of December.

Respectfully submitted,
A. B. STOUT,
Director of the Laboratories.

REPORT OF THE SUPERINTENDENT OF BUILDINGS AND GROUNDS

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1921.

Regulating and Grading

The greater part of the regulating and grading accomplished during the year was confined to the iris garden. Nearly an acre of ground was graded and sodded and along the path on the eastern side of the road leading to the iris garden a bank 10 feet wide and 600 feet long was also graded and sodded. Another bank 8 feet wide and 460 feet long was graded and sodded. This bank lies along the path on the eastern side of the red pine collection. The old lane in the red pine collection was graded and surfaced with topsoil and it is now ready for planting.

Contractors working in the vicinity of the Garden and looking for a suitable place to dispose of soil taken from excavations, carted about 6,500 cubic yards of soil into the grounds. This was done at the contractor's expense. It contained about 1,000 yards of topsoil and we stacked this for future use at several places. Of the rough soil, 1,500 yards were placed on the new road at the northern end of Long Lake, 800 yards were used to fill in the frog pond, 2,500 yards were deposited in the lowlands near Pelham Parkway, and 200 yards were used in the iris garden.

About 300 yards of stone were blasted in the quarry near conservatory range 2 and were used for foundations for fences and paths. The paths in the iris garden received about 300 yards of stone that had been blasted from the quarry north of the museum building.

Drainage

For the purpose of draining the rose garden and the mansion road near the entrance, 170 feet of 8-inch drain pipe, 136 feet of 10-inch drain pipe and 90 feet of 12-inch drain pipe were installed. A catch-basin and a culvert 20 feet long, 18 inches high and 15 inches wide were built and connected with the culvert that takes the water across Pelham Parkway and thence into the Bronx River. Two catch-basins and a culvert were built in the iris garden and then connected with the culvert near the entrance to the herbaceous grounds. The culvert was covered with stone flags for a distance of about 80 feet. It opens into a brook 3 feet wide and 200 feet long. The banks of the brook were walled with boulders and its bed lined with small round stones. Five single and two double culverts were erected along the road east of the iris garden and a large culvert 18 inches high and 2 feet wide was built along the serpentine road so as to drain the surplus water flowing from the iris garden into the brook. In order to take the water from the propagating houses, a connection was made with the sewer at Bronx Park East. For this 38 feet of 6-inch pipe were used. Thirty-six feet of 6-inch pipe were used for drainage in the low ground and for carrying water under the path on the eastern side of the Bronx River north of the mansion.

Water Supply

A drinking fountain was placed in the recreation grounds east of the iris garden and 225 feet of 1-inch galvanized pipe were needed to connect it with the water main in the iris garden. The water system was replaced in the stable,

necessitating the use of 260 feet of 1½-inch galvanized pipe. The water systems of conservatory range 1, the comfort stations, and the fountains were repaired wherever necessary.

Paths

A 10-foot path 690 feet long, leading from the rock garden through the hemlock grove and to the serpentine road, was built and completed. On the eastern side of the road near the iris garden, a 10-foot path 580 feet long was constructed, 460 feet of which were completed, and on the eastern side of the serpentine road a path 600 feet long and 10 feet wide was built and partly paved. The unfinished path in the iris garden, 850 feet long, was also finished, as was the uncompleted path leading to the cherry-garden shelter-house. A 10-foot path 300 feet long, approaching the falls, was constructed in the hemlock grove. At the southern end of the rose garden through the glen an 8-foot path 290 feet long was also completed and a 10-foot cross path 165 feet long was lined and made ready for paving. The paths around conservatory range 1, those leading to the museum building, and other paths throughout the grounds were resurfaced and rolled.

Buildings

The northern wall on the mezzanine platform in the museum building was furred and plastered. The roof over the library and over the western section of the museum building received necessary repairs. The carpenter repaired the doors and windows, made a map cabinet for the director's office and a table for the assistant director's office. The mezzanine floor and the western hall and typewriting room on the top floor of the museum building were painted. All necessary repairs to the water system and the lavatories were made by the plumber and the steam engineers made numerous repairs to the steam system in the museum building.

The wooden rafters, bars, and glass were replaced on the lower dome of house 1, conservatory range 1, by a contractor. Our painter replaced all broken glass and painted the exterior of houses 6, 7, and 8 and the interior of houses 7 and 8 of conservatory range 1. The masons constructed two side benches in houses 7, 8, and 14 and rebuilt the side wall of the entrance to the cellar of conservatory range 1. They also pointed the steps and stone work. The carpenter built forms for the benches and repaired the doors and sash wherever it was necessary. The steam engineers made repairs to the steam system of conservatory range 1 and replaced three sets of coils in house 1 and two sets in houses 8 and 15. The plumber repaired the water system and the leaders.

All the broken glass was replaced in conservatory range 2 and the propagating houses, and snow guards were placed wherever needed. The roof of the stable was repaired.

The water arches in five boilers of power house 1 were removed and cast iron arches were installed instead. Extra heavy brass pipe was used for making the connections. The five fire boxes and arches were rebuilt by the masons. At power house 2 two fire boxes and arches were rebuilt.

Extensive repairs were made in comfort stations 1, 2, and 4 and a set of five new urinals was installed in comfort station 1.

The windows, doors, and porches of the mansion were repaired.

Grounds

Ten cedar benches were constructed by the carpenter and as many received repairs. He also repaired the railing along the Bronx River and made twenty signs. The masons erected two concrete benches in the cherry-garden shelter-house and three in the shelter-house in the herbaceous grounds. We have continued to utilize all old steam-pipe removed from conservatory range 1 for railing

along the paths. The plumber erected 785 feet of this pipe along the path at the horticultural garden entrance. It then received two coats of paint.

Two coats of paint were given to the fence built along the boundary of Fordham University. The foundation and wall along the Southern Boulevard were extended for a distance of 200 feet. On top of this foundation we placed nine 8-foot piers, with caps and coping stone, and 670 feet of 6-foot iron fencing. For a fence along Pelham Parkway near the mansion entrance, a foundation 165 feet long, 22 inches wide and 3 feet deep was erected, and over this we constructed a wall 1 foot high and 18 inches wide. We put up seven piers 20 inches square and 8 feet high, with caps and coping stone, two gate piers 46 inches square and 12 feet 9 inches high, and two 36-inch piers 9 feet high, and also erected 155 feet of iron fencing. Along Pelham Parkway, midway between the Bronx River and the Southern Boulevard, a cedar fence was built 3 feet high for a distance of 450 feet. At the southern end of Long Lake a similar fence was constructed 300 feet long and 3 feet high.

By running the gasoline engine for eighteen days, enough wood was cut from the fallen or dead trees to provide fuel for the propagating houses and the mansion for two months. The uprooting of the poison ivy was continued.

Groups of young people, averaging nearly ten parties each week from May until September, and consisting of about 50 to 2,000 persons each, came to the Garden. These children attended the public and Sunday schools of the Boroughs of Manhattan, Brooklyn and The Bronx, and some parties came from Jersey City. They were escorted to our three picnic grounds where they would have their lunches and frolic for the day. Special guards were detailed to the picnic grounds daily.

On Saturdays, Sundays, and holidays, from June until September, two city officers in civilian clothes were assigned to the Garden. Our own keepers and twelve guards selected from the gardeners and laborers also aided in the protection of the grounds. At all other times during the year one police officer has been stationed in the Garden. The officers of the Police Department placed over 200 persons under arrest for violations of the park ordinances. The offenders were fined from one to ten dollars each by the magistrates. During the summer months about 50,000 visitors came to the Garden on Saturdays and Sundays, but during July and August this number was greatly augmented. Little damage was done to our plantations because of the constant vigilance of our employes.

It was necessary to assign a guard continuously in the vicinity of the dahlia, canna, and gladiolus collections on account of the number of admirers who visited them daily. In fact, the dahlia collection had to be guarded both night and day.

Respectfully submitted,

ARTHUR J. CORBETT,

Superintendent of Buildings and Grounds.

REPORT OF THE BIBLIOGRAPHER

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1921.

Bibliographic and editorial work, and the assistance afforded to users of the library, have kept the time of the bibliographer fully occupied.

Difficulties in the printer's trade, which have been referred to in several former reports, culminated in a general strike in May. This strike has not been settled, but conditions have been slowly approaching normal for a long time without any formal settlement. All scientific publication has been delayed, and the Garden has not been exempt from the effects of the strike.

Only two parts of *North American Flora* have appeared during the year. Volume 7, part 6 was issued in February, and Volume 32, part 2, in May. The initial number of Volume 6 is nearly ready, and another part is in the hands of the printers. An abundance of manuscript is available as soon as the printers can handle it, and the work has now been divided between two printing establishments.

The final number of the fifth volume of *Addisonia*, containing general indexes to the first five volumes, did not appear until June, but the first number of volume 6 was issued only a few days later, and two other numbers of this volume have since appeared. The concluding number is not yet quite ready. The death of Mr. Nash, who had been associated with the writer in the editorship of *Addisonia* from its establishment in 1916, occurred while the second number was in press. The editorship of this journal has never been burdensome, but Mr. Nash was always ready to do his full share of it thoroughly and cheerfully, in spite of the fact that his other duties were always pressing.

The publications of the bibliographer during the year have consisted chiefly of brief papers in *Rhodora* and the *American Fern Journal*, of biographical notices of persons mentioned in the Schweinitz-Torrey correspondence, appended to that correspondence as printed in the Memoirs of the Torrey Botanical Club, and of various biographic foot-notes in the *Journal of the New York Botanical Garden*. Three lectures were given in the Museum Building on Saturday afternoons, in June, July, and October.

Respectfully submitted,

JOHN HENDLEY BARNHART,

Bibliographer.

REPORT OF THE LIBRARIAN

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1921.

The census of the library recently taken shows a total of 30,534 bound volumes, an increase of 584 over the census of 1920. Of these there were acquired by purchase 152, by gift 33, and by exchange and deposit 56. Two shipments were sent to the bindery and 424 books have been bound, including 32 belonging to Columbia University. The largest single purchase was that of over 100 volumes and many pamphlets from the library of Dr. J. H. Barnhart. This collection included, among other rare works, 32 original Linnaean dissertations. The principal accessions have been listed as hitherto in the *Journal.*

There have been added to the catalogue 1,458 type-written cards and 2,184 of the printed ones issued by the Torrey Botanical Club. The filing of a large number of guide cards in addition to those above mentioned has taxed the capacity of the cases to the utmost and the installing of an additional one seems imperative.

Since no list of serials currently received has been printed since the report of the Librarian for 1916 (*Bulletin* 9: 342–363) and very many changes have occurred during the intervening period, it seems highly desirable that such a list should be appended to the present report.

Respectfully submitted,

SARAH H. HARLOW,

Librarian.

LIST OF SERIALS.

*Serials subscribed for by the Garden.

†Serials subscribed for by Columbia University and deposited at the Garden.

‡Serials received in exchange by the Torrey Botanical Club and deposited at the Garden.

§Serials whose receipt is temporarily interrupted.

All others are received in exchange by the Garden.

Agricultural Experiment Station, Auburn, Ala. [*Publications.*]
" " " Tuskegee, Ala. "
" " " Sitka, Alaska. "
" " " Tucson, Ariz. "
" " " Fayetteville, Ark. "
" " " Berkeley, Calif. "
" " " Fort Collins, Colo. "
" " " New Haven, Conn. "
" " " Storrs, Conn. "
" " " Newark, Del. "
" " " Haina, Dom. Rep. W. I.
" " " Gainesville, Fla. "
" " " Experiment, Ga. "
" " " Guam. "
" " " Honolulu, Hawaii "
" " " Moscow, Id. "
" " " Urbana, Ill. "
" " " Lafayette, Ind. "
" " " Ames, Iowa "
" " " Manhattan, Kan. "
" " " Lexington, Ky. "
" " " Baton Rouge, La. "
" " " Orono, Me. "
" " " College Park, Md. "
" " " Amherst, Mass. "
" " " East Lansing, Mich. "
" " " University Farm, St. Paul, Minn. "
" " " Agricultural College, Miss. "
" " " Columbia, Mo. "
" " " Bozeman, Mont. "
" " " Lincoln, Neb. "
" " " Reno, Nev. "

Agricultural Experiment Station, Durham, N. H. [*Publications.*]
" " " New Brunswick, N. J. "
" " " State College, N. M. "
" " " Geneva, N. Y. "
" " " Ithaca, N. Y. "
" " " Raleigh, N. C. "
" " " Agricultural College, N. D. "
" " " Wooster, Ohio "
" " " Stillwater, Okla. "
" " " Corvallis, Ore. "
" " " State College, Pa. "
" " " Mayaguez, Porto Rico "
" " " Kingston, R. I. "
" " " Clemson College, S. C. "
" " " Brookings, S. Dak. "
" " " Knoxville, Tenn. "
" " " College Station, Tex. "
" " " Logan, Utah "
" " " Burlington, Vt. "
" " " Blacksburg, Va. "
" " " St. Croix, Virgin Is. "
" " " Pullman, Wash. "
" " " Morgantown, W. Va. "
" " " Madison, Wis. "
" " " Laramie, Wyo. "

Agricultural Gazette of New South Wales, Sydney, N. S. W.

Agriculture Pratique des Pays Chauds: see L'Agriculture Pratique des Pays Chauds.

Alabama. Geological Survey, University, Ala. *Bulletin, Report, Monograph.*

A Lavoura; see Sociedade Nacional de Agricultura, Rio de Janeiro.

Algiers. Société d'Histoire Naturelle de l'Afrique du Nord: see Société d'Histoire Naturelle de l'Afrique du Nord.

†Allgemeine Botanische Zeitschrift, Karlsruhe, Germany.

Amateur des Champignons: see L'Amateur des Champignons.

America. Botanical Society: see Botanical Society of America.

America. Geological Society: see Geological Society of America.
America. Society of American Florists: see Society of American Florists.
American Academy of Arts and Sciences, Boston, Mass. *Proceedings.*
American Association of Museums, Providence, R. I. *Museum Work.*
*American Botanist, Joliet, Ill.
*American Fern Journal, Auburndale, Mass.
*American Florist, Chicago, Ill.
American Forestry, Washington, D. C.
American Genetic Association: see Journal of Heredity.
American Geographical Society: see Geographical Review.
American Institute of Park Executives: see Parks & Recreation.
American Journal of Botany, Lancaster, Pa.
American Journal of Pharmacy, Philadelphia, Pa.
American Midland Naturalist, Notre Dame, Ind.
American Museum of Natural History, New York, N. Y. *Bulletin, Report, Natural History.*
American Peony Society, Clinton, N. Y. *Bulletin of Peony News.*
American Philosophical Society, Philadelphia, Pa. *Proceedings.*
American Rose Society, Harrisburg, Pa. *American Rose Annual.*
*American Society for Horticultural Science, College Park, Md. *Proceedings.*
Amsterdam. Koloniaal Institut, Amsterdam, Holland. *Jaarverslag.* Afdeeling Handelsmuseum. *Bericht.*
§Anales Cientificos Paraguayos: Botanica, Puerto Bertoni, Paraguay.
Anexos das Mémorais do Instituto de Butantan: see Butantan. Instituto de Butantan.
†Annales des Sciences Naturelles: Botanique; Paris, France.
Annales Mycologici, Berlin, Germany.
Annali di Botanica, Rome, Italy.
*Annals of Applied Biology, Cambridge, England.
*Annals of Botany, London, England.
Annals of the Bolus Herbarium; see Bolus Herbarium.
Antwerp. Jardin Botanique, Antwerp, Belgium. *Seed Lists.*
Appalachian Mountain Club, Boston, Mass. *Appalachia.*
Arcachon, Société Scientifique d'Arcachon: see Société

Scientifique d'Arcachon.
*Archiv der Pharmazie, Berlin, Germany.
*Archiv für Zellforschung, Leipzig, Germany.
Argentina. Sociedad Cientifica Argentina; see Sociedad Cientifica Argentina.
Arkiv för Botanik, Stockholm, Sweden.
*Arnold Arboretum, Jamaica Plain, Mass. *Bulletin of Popular Information, Journal.*
Arquivos Indo-Portugueses de Medicina e Historia Natural, Nova Gôa, India.
Asiatic Society of Bengal, Calcutta, India. *Journal.*
*Association Française pour l'Avancement des Sciences, Paris, France. *Compte Rendu.*
Barcelona. Junta de Ciencies Naturals, Barcelona, Spain. *Anuari.*
Barcelona. Real Academia de Ciencias y Artes, Barcelona, Spain. *Memorias, Boletin.*
Basel. Naturforschende Gesellschaft, Basel, Switzerland. *Verhandlungen.*
Bayerische Akademie der Wissenschaften zu München: mathematisch-physikalische Klasse, Munich, Bavaria. *Sitzungsberichte.*
Bayerische botanische Gesellschaft zur Erforschung der heimischen Flora. Munich, Bavaria, *Berichte, Mitteilungen, Kryptogamische Forschungen.*
Belgium. Société Royal de Botanique de Belgique, Brussels, Belgium. *Bulletin.*
Bengal. Asiatic Society: see Asiatic Society of Bengal.
Bergen's Museum, Bergen, Norway. *Aarbok.*
Bergianska Trädgården, Stockholm, Sweden. *Acta Horti Bergiani.*
‡Berlin. Botanischer Garten, Berlin, Germany. *Notizblatt.*
Bermuda. Department of Agriculture, Paget East, Bermuda. *Report.*
Bern. Botanischer Garten, Bern, Switzerland. *Jahresbericht, Seed Lists.*
Bernice Pauahi Bishop Museum, Honolulu, Hawaii. *Occasional papers.*
†Bibliotheca Botanica, Stuttgart, Germany.
*Biologisches Centralblatt, Leipzig, Germany.

*Bolus Herbarium (University of Cape Town.) *Annals.*
Boston. Board of Metropolitan Park Commissioners, Boston, Mass. *Report.*
‡Boston Society of Natural History, Boston, Mass. *Proceedings.*
*Botanical Abstracts, Baltimore, Md.
Botanical Gazette, Chicago, Ill.
Botanical Society and Exchange Club of the British Isles, Arbroath, Scotland. *Report.*
Botanical Society of America. *Publications.*
†Botanische Jahrbücher, Leipzig, Germany.
*Botanisches Centralblatt, Jena, Germany.
*Botanisches Centralblatt, Beihefte, Dresden, Germany.
‡Botanisk Tidsskrift, Copenhagen, Denmark.
Botaniska Notiser, Lund, Sweden.
Botaniste: see Le Botaniste.
Brandenburg. Botanischer Verein der Provinz Brandenburg, Berlin, Germany. *Verhandlungen.*
§Bremen. Naturwissenschaftlicher Verein, Bremen, Germany. *Abhandlungen.*
British Columbia. Botanical Office, Vancouver, B. C. *Annual Report.*
British Columbia. Provincial Museum, Victoria, B. C. *Report.*
*British Mycological Society, Worcester, England. *Transactions.*
Brooklyn Botanic Garden, Brooklyn, N. Y. *Record, Contributions, Leaflets, Memoirs.*
Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y. *Bulletin, Report, Science Bulletin, Children's Museum News.*
Brussels. Institut Botanique Léo Errera, Brussels, Belgium. *Recueil.*
Brussels. Jardin Botanique de l'Etat, Brussels, Belgium. *Bulletin.*
Bryologist, Pittsburgh, Pa.
Buenos Aires. Museo de Farmacologia, Buenos Aires, Argentina. *Trabajos.*
Buenos Aires. Museo Nacional, Buenos Aires, Argentina. *Anales.*
Buffalo Park Commissioners, Buffalo, N. Y. *Annual Report.*
Buffalo Society of Natural Sciences, Buffalo, N. Y. *Bulletin.*

*Buitenzorg. Jardin Botanique, Buitenzorg, Java. *Annales.*
Buitenzorg. Jardin Botanique, Buitenzorg, Java. *Bulletin.*
Bulletin du Jardin Colonial et des Jardins d'Essai: see L' Agriculture Pratique des Pays Chauds.
Bulletin of Peony News: see American Peony Society.
Butantan. Instituto de Butantan: Secção de Botânica, S. Paulo, Brazil. *Anexos das Mémorias.*
Calcutta. Indian Museum, Calcutta, India. *Report on the Industrial Section.*
†Calcutta. Royal Botanic Gardens, Calcutta, India. *Annals.*
California Academy of Sciences, San Francisco, Cal. *Proceedings.*
California State Board of Forestry, Sacramento, Cal. *Bulletin, Circular, Biennial Report.*
California State Commission of Agriculture, Sacramento, Cal. *Monthly Bulletin.*
California, University of. Berkeley, Cal. *Publications in Agricultural Sciences, Publications in Botany.*
California, University of: Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, Cal. *Publications.*
*Canadian Field Naturalist, Ottawa, Can.
Carnegie Institution of Washington, Washington, D. C. *Year Book, Botanical Publications.*
Carnegie Institution of Washington: Department of Botanical Research, Tucson, Ariz. *Report.*
Carnegie Institution of Washington: Station for Experimental Evolution, Cold Spring Harbor, N. Y. *Papers, Report.*
Carnegie Museum, Pittsburgh, Pa. *Annals, Annual Report, Memoirs.*
Cellule: see La Cellule.
*Centralblatt für Bakteriologie: Abtheilung I, Jena, Germany.
*Centralblatt für Bakteriologie: Abtheilung II, Jena, Germany.
Charleston Museum, Charleston, S. C. *Bulletin, Contributions.*
Chicago. University of, Chicago, Ill. *Contributions from the Hull Botanical Laboratory.*
Christiania. Hortus Botanicus, Christiania, Norway. *Seed Lists.*
Christiania. Physiographiske Forening; see Nyt Magazin for Naturvidenskaberne.

Christiania. Videnskabs-Selskabet, Christiania, Norway. *Skrifter.*

Cincinnati Society of Natural History, Cincinnati, Ohio. *Journal.*

Cluj. Jardin Botanique, Cluj, Roumania. *Bulletin, Seed Lists.*

Colombia. Ministerio de Agricultura y Comercio, Bogota, Colombia. *Revista Agricola.*

Colorado College, Colorado Springs, Colo. *Publications.*

Colorado State Board of Agriculture, Denver, Colo. *Annual Report.*

Colorado. University of, Boulder, Colo. *Studies.*

Columbia University, New York, N. Y. *Annual Report, Catalogue.*

Connecticut. Geological and Natural History Survey, Hartford, Conn. *Bulletin.*

Copenhagen. Botanic Gardens, Copenhagen, Denmark. *Arbejder.*

Copenhagen. Société Botanique: see Botanisk Tidsskrift.

Cuba. Estación Central Agronómica, Santiago de las Vegas, Cuba, W. I. *Bulletin, Circular, Report.*

Cuba Review, New York, N. Y.

Cuba. Secretaria de Agricultura, Havana, Cuba. *Revista de Agricultura.*

Cuba. Sociedad Cubana de Historia Natural "Felipe Poey:" See Sociedad Cubana de Historia Natural "Felipe Poey."

Dansk Botanisk Arkiv, Copenhagen, Denmark.

Davenport Academy of Sciences, Davenport, Ia. *Proceedings.*

Delaware County Institute of Science, Media, Pa. *Proceedings.*

Denison University, Granville, O. *Bulletin of the Scientific Laboratories.*

Der Pilz und Kraüterfreund, Heilbronn a N., Germany.

Desert Botanical Laboratory: see Carnegie Institution, Department of Botanical Research.

Detroit. Commissioner of Parks and Boulevards, Detroit, Mich. *Annual Report.*

†Deutsche Botanische Gesellschaft, Berlin, Germany. *Berichte.*

Deutsche Dendrologische Gesellschaft, Wendisch-Wilmersdorf bei Thyrow, Germany. *Mitteilungen.*

Direccion de Estudios Biologicos: see Mexico, secretaria de Fomento.

Dorpat: see Jurjeff.

Dublin. Royal Botanic Gardens, Glasnevin, Dublin, Ireland. *Seed Lists.*

Durham. University of Durham Philosophical Society, New Castle-upon-Tyne, England. *Proceedings.*

Dutch Guiana: see Suriname.

Ecological Society of America, Tucson, Ariz. *Bulletin, Ecology.*

‡Edinburgh Botanical Society, Edinburgh, Scotland. *Transactions.*

Edinburgh. Royal Botanic Garden, Edinburgh, Scotland. *Seed Lists, Notes.*

Elisha Mitchell Scientific Society, Chapel Hill, N. C. *Journal.*

Empire State Forest Products Association, Albany, N. Y. *Bulletin.*

Field Museum of Natural History, Chicago, Ill. *Publications: Botanical Series, Report Series.*

Finnland. Forstwissenschaftliche Gesellschaft: see Forstwissenschaftliche Gesellschaft in Finnland.

*Flora, Jena, Germany.

Florence. Istituto Agricolo Coloniale Italiano, Florence, Italy. *L'Agricoltura Coloniale.*

Florida. Department of Agriculture, Tallahassee, Fla., *Florida Quarterly Bulletin, Biennial Report.*

Florida State Geological Survey, Tallahassee, Fla. *Annual Report.*

Florist's Exchange, New York, N. Y.

Flower Grower, Calcium, N. Y.

Forest Leaves: see Pennsylvania Forestry Association.

Forstwissenschaftliche Gesellschaft in Finland, Helsingfors, Finland. *Acta Forestalia Fennica.*

†France. Société Botanique de France, Paris, France. *Bulletin.*

France. Société Dendrologique de France, Paris, France. *Bulletin.*

†France. Société Mycologique de France, Paris, France. *Bulletin.*

Frankfort on Main. Senckenbergische Naturforschende Gesellschaft, Frankfurt a/M., Germany. *Berichte.*

†Garden, London, England.

*Garden Magazine, New York, N. Y.

†Gardener's Chronicle, London, England.
Gardener's Chronicle of America, New York, N. Y.
*Gardening, Chicago, Ill.
*Gartenflora, Munich, Bavaria, Germany.
*Genetics. Princeton, N. J. *
Geneva. Jardin d'Acclimatation Alpin, Geneva, Switzerland. *Seed Lists.*
Geneva. Jardin Botanique de Genève, Geneva, Switzerland. *Annuaire.*
Geneva. Société Botanique de Genvèe, Geneva, Switzerland. *Bulletin.*
Geneva. Université de Genève: Laboratoire de Botanique, Geneva, Switzerland. [*Etudes.*]
Geographical Review, New York, N. Y.
Geological Society of America, New York, N. Y. *Bulletin.*
Gray Herbarium: see Harvard University.
Groningen. Jardin Botanique de l'Université, Groningen, Holland. *Seed Lists.*
Hamburg. Naturwissenschaftlicher Verein, Hamburg, Germany. *Verhandlungen*, [*Botanical papers from the Abhandlungen*].
Hamburgische Institut für allgemeine Botanik, Hamburg, Germany. *Mitteilungen.*
*Hardwood Record, Chicago. Ill.
Harvard University, Cambridge, Mass. *Contributions & Memoirs from the Gray Herbarium, Contributions from the Cryptogamic Laboratory, Contributions from the Phanerogamic Laboratory.*
Havana. Academia de Ciencias Medicas, Fisicas y Naturales de la Habana, Havana, Cuba. Anales.
Havana. Universidad de la Habana, Havana, Cuba. *Revista de la Facultad de Letras y Ciencias.*
Hawaii. Board of Commissioners of Agriculture and Forestry, Honolulu, T. H. *Report, Hawaiian Forester and Agriculturist.*
Hawaii. Sugar Planters' Association Experiment Station, Honolulu, T. H. *Report, Bulletin.*
‡Hedwigia, Dresden, Germany.
Helsingfors. Universitets Botaniska Institution, Helsingfors, Finland. [*Miscellaneous botanical reprints and papers.*]
Holland. Société Botanique Néerlandaise: see Société Botani-

que Néerlandaise.
Hooker's Icones Plantarum: see Icones Plantarum.
Horticulture, Boston, Mass.
Hortus Thenesis: see Tirlemont.
Hull Botanical Laboratory: see Chicago University.
‡Icones Plantarum, London, England.
Illinois Academy of Science, Springfield, Ill. *Transactions.*
Illinois State Natural History Survey, Urbana, Ill. *Bulletin.*
Illinois. University of, Urbana, Ill. *Biological Monographs.*
India. Agricultural Research Institute and College, Pusa, India. *Annual Report.*
India. Botanical Survey of India, Calcutta, India. *Records.*
India. Department of Agriculture in India, Pusa, India. *Memoirs.*
*India Rubber World, New York, N. Y.
Indiana Academy of Science, Indianapolis, Ind. *Proceedings.*
Indiana Horticultural Society, LaFayette, Ind. *Transactions, Hoosier Horticulture.*
Instituto de la Salle: see Sociedad de Ciencias Naturales del Instituto de la Salle.
‡International Institute of Agriculture, Rome, Italy. *International Crop Report and Agricultural Statistics, International Review of Agricultural Economics, International Review of the Science and Practice of Agriculture.*
Iowa Academy of Sciences, Des Moines, Iowa. *Proceedings.*
Iowa Department of Agriculture, Des Moines Iowa. *Year-book.*
Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. *Contributions from the Botanical Department.*
Iowa State University, Iowa City, Iowa. *Studies in Natural History.*
Irish Gardening. Dublin, Ireland.
Italy. Societa Botanicà Italiana: see Società Botanica Italiana.
*Jahrbücher für Wissenschaftliche Botanik, Leipzig, Germany.
*Jahresbericht der Vereinigung der Vertreter der Angewandten Botanik, Berlin, Germany.
†Jahresbericht über die Fortschritte in der Lehre von den Pathogenen Mikroorganismen, Leipzig, Germany.
Jamaica. Department of Agriculture, Hope Gardens, Kingston, Jamaica. *Annual Report.*

Java. Proefstation voor Suikerriet in West Java, Dutch East Indies. *Mededeelingen.*

Johns Hopkins University, Baltimore, Md. *Circulars.*

§*Journal d'Agriculture Tropicale, Paris, France.

*Journal of Agricultural Science, Cambridge, Eng.

Journal of the Arnold Arboretum: see Arnold Arborteum.

*Journal of Bacteriology, Baltimore, Md.

*Journal of Biological Chemistry, Baltimore, Md.

‡Journal of Botany, British and Foreign, London, England.

*Journal of Ecology, Cambridge, Eng.

*Journal of Forestry, Washington, D. C.

*Journal of General Physiology, Baltimore, Md.

*Journal of Genetics, Cambridge, Eng.

*Journal of Heredity, Washington, D. C.

*Journal of Indian Botany, Madras, India.

§Jurjeff. University of Jurjeff (Dorpat), Russia. *Acta Horti Botanici Jurjevensis.*

Kansas Academy of Sciences, Topeka, Kans. *Transactions.*

Kansas State Board of Agriculture, Topeka, Kans. *Quarterly Report, Biennial Report.*

Kansas University Science Bulletin, Lawrence, Kans.

Kew. Royal Gardens, Kew, England. *Bulletin of Miscellaneous Information.*

§Kharkow. Société des Naturalistes de l'Université Imperiale à Kharkow, Kharkow, Russia. *Travaux.*

*La Cellule, Lierre, Belgium.

L'Agricoltura Coloniale: see Florence, Istituto Agricolo.

§*L'Agriculture Pratique des Pays Chauds, Paris, France.

§*L'Amateur des Champignons, Paris, France.

*Landscape Architecture, Brookline, Mass.

La Nouva Notarisia, Modena, Italy.

La Plata. Museo de La Plata, La Plata, Argentina. *Revista.*

*Leaflets of Philippine Botany, Manilla, P. I.

*Le Botaniste, Paris, France.

Leland Stanford Junior University: see Stanford University.

Le Naturaliste Canadien, Quebec, Canada.

Leyden. Ryks Herbarium, Leyden, Holland. *Mededeelingen.*

Leyden. University Botanic Garden, Leyden, Holland. *Seed Lists.*

Lilly Scientific Bulletin, Indianapolis, Ind.

†Linnean Society, London, England. *Transactions: Botany*, *Journal: Botany.*

§†Lisbon. Instituto Bacteriologico Camara Pestana, Lisboa, Portugal. *Arquivos.*

Lloyd Library, Cincinnati, Ohio. *Mycological Writings.*

London. Royal Botanic Society, London, Eng. *Quarterly Summary* and *Meteorological Readings.*

London. Royal Colonial Institute, London, Eng. *United Empire, Yearbook.*

London. Royal Horticultural Society, London, England. *Journal.*

‡London. Royal Microscopical Society, London, England. *Journal.*

Louisiana State Museum, New Orleans, La. *Annual Report.*

Lund. Hortus Botanicus, Lund, Sweden. *Seed Lists.*

Luxemburg. Société des Naturalistes: see Société des Naturalistes Luxumbourgeois.

Lyons. Société Botanique: see Société Botanique de Lyon.

Macon. Société d'Histoire Naturelle: see Société d'Histoire Naturelle de Macon.

Madrid. Hortus Botanicus, Madrid, Spain. *Seed Lists.*

Maine. Commissioner of Agriculture, Augusta, Maine. *Report.*

Maine. Forest Commissioner, Augusta, Maine. *Report.*

†Malpighia, Genoa, Italy.

Manchester Museum, Owens College, Manchester, England. *Publications.*

Marcellia, Avellino, Italy.

Marseilles. Musée Colonial, Marseilles, France. *Annales.*

Maryland Geological and Natural History Survey, Baltimore, Md. [*Publications.*]

Massachusetts Horticultural Society, Boston, Mass. *Transactions.*

Massachusetts State Board of Agriculture, Boston, Mass. *Annual Report.*

Mazama, Portland, Ore.

Mexico. Direccion General de Agricultura, San Jacinto, Mex. *La Revista Agricola.*

Mexico. Secretaria de Agricultura y Fomento: Direccion de Estudios Biologicos, Mexico, Mex. *Boletin.*

Michigan Academy of Science, Ann Arbor, Mich. *Report.*
Minnesota. Geological and Natural History Survey, Minneapolis, Minn. [*Publications.*]
Missouri Botanical Garden, St. Louis, Mo. *Annals, Bulletin.*
Missouri State Board of Agriculture, Columbia, Mo. *Monthly Bulletin, Year Book.*
Missouri. University of, Columbia, Mo. *Bulletin; Science Series.*
†Monatsschrift für Kakteenkunde, Neudamm, Germany.
§Moscow. Institut Agronomique, Moscow, Russia. *Annales.*
§Moscow. Société Impériale des Naturalistes, Moscow, Russia. *Bulletin.*
Mountaineer, Seattle, Wash.
Munich, Bayerische Akademie der Wissenschaften: see Bayerische Akademie der Wissenschaften.
Musée Teyler, Haarlem, Holland. *Archives.*
Museum Work: see American Association of Museums.
Naples. Società di Naturalisti: see Società di Naturalisti in Napoli.
Nassauischer Verein für Naturkunde, Wiesbaden, Germany. *Jahrbücher.*
Natal Herbarium, Durban, Natal. [*Papers by the mycologist.*]
National Academy of Sciences, Baltimore, Md. *Proceedings.*
§Naturae Novitates, Berlin, Germany.
Natural History: see American Museum of Natural History.
Naturaliste Canadien: see Le Naturaliste Canadien.
*Nature, London, England.
Nature Study Review, Ithaca, N. Y.
Nebraska State Horticultural Society, Lincoln, Neb. *Annual Report.*
Nederlandsch-Indie. Department von Landbouw, Niverheid en Handel, Buitenzorg, Java. *Jaarboek, Mededeelingen.*
Nerderlandsch Kruidkungig Archief: see Société Botanique Neerlandaise.
Newark. Shade Tree Commission, Newark, N. J. *Annual Report.*
New England Botanical Club: see Rhodora.
New Jersey State Horticultural Society, Trenton, N. J. *Proceedings.*
*New Phytologist, London, England.

New South Wales. Linnean Society, Sydney, N. S. W. *Proceedings.*

New York Academy of Sciences, New York, N. Y. *Annals.*

New York. Art Commission, New York, N. Y. *Annual Report.*

New York. Conservation Commission, Albany, N. Y. *Annual Report, Bulletin,* The Conservationist.*

New York Farmers, New York, N. Y. *Proceedings.*

New York Horticultural Society, New York, N. Y. *Journal.*

New York. Metropolitan Museum of Art, New York, N. Y. *Bulletin.*

New York. Municipal Art Society, New York, N. Y. *Bulletin.*

New York. Municipal Reference Library, New York, N. Y. *Notes.*

New York Public Library, New York, N. Y. *Bulletin.*

New York State College of Forestry at Syracuse University, Syracuse, N. Y. *Bulletin, Press Bulletin, Technical Publication.*

New York State Department of Agriculture, Albany, N. Y. *Annual Report.*

§New York State Forestry Association, Syracuse, N. Y. *New York Forestry, The Rivet.*

New York State Institute of Applied Agriculture. Farmingdale, L. I. *The Furrow.*

New York State Museum of Natural History, Albany, N. Y. *Annual Report.*

New York Zoological Society, New York, N. Y. *Report, News Bulletin.*

New Zealand. Department of Agriculture, Wellington, New Zealand. *Annual Report, Bulletin, Journal of Agriculture.*

Nictheroy. Escola Superior de Agricultura e Medicinia Veterinaria. Nictheroy. Brazil. *Archivos.*

North Carolina. Department of Agriculture, Raleigh, N. C. *Bulletin.*

Norway. Kongelige Norske Videnskabers Selskab, Trondhjem, Norway. *Skrifter.*

Nova Gôa. Instituto Bacteriologico: see Arquivos Indo-Portugueses de Medicin e Historia Natural.

Nova Scotian Institute of Science, Halifax, N. S. *Proceedings and Transactions.*

Nuova Notarisia; see La Nuova Notarisia.

Nuovo Giornale Botanico Italiano: see Società Botanica Italiana.

§Nuremberg. Naturhistorische Gesellschaft, Nuremberg, Germany. *Abhandlungen, Mitteilungen.*

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Ohio (State) Biological Survey, Columbus, Ohio. *Bulletin.*

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Ohio State Academy of Science, Columbus, Ohio. *Proceedings.*

Ohio State Board of Agriculture, Columbus, Ohio. *Annual Report.*

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†Osterreichische Botanische Zeitschrift, Vienna, Austria.

Ottawa. Central Experiment Farm, Ottawa, Canada. *Bulletin, Report, Seasonable Hints.*

Palermo. R. Orto Botanico, Palermo, Italy. *Bolletino.*

Palisades Interstate Park Commissioners, New York, N. Y. *Report.*

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Paris. Museum d'Histoire Naturelle, Paris, France. *Bulletin, Notulae Systematicae.*

Park and Cemetery, Chicago, Ill.

*Park International, Washington, D. C.

Parks and Recreation, Minot, N. D.

Pennsylvania Department of Agriculture, Harrisburg, Pa. *Annual Report, Bulletin.*

Pennsylvania Department of Forestry, Harrisburg, Pa. *Report, Bulletin.*

Pennsylvania Forestry Association, Philadelphia, Pa. *Forest Leaves.*

Pennsylvania. University of, Philadelphia, Pa. *Contributions from the Department of Botany.*

Peradeniya. Royal Botanic Gardens, Peradeniya, Ceylon. *Annals.*

§Petrograd. Academie des Sciences, Petrograd, Russia. *Travaux du Musée Botanique.*

§Petrograd. Institut et Jardin Botanique de l'Universite, Petrograd, Russia. *Scripta Botanica, Seed Lists.*

§†Petrogad. Jardin Botanique, Petrograd, Russia. *Acta, Bulletin, Seed Lists.*

Philadelphia. Academy of Natural Sciences, Philadelphia, Pa. *Proceedings.*

Philadelphia Commercial Museum, Philadelphia, Pa. *Report.*

Philippine Agriculturist, Los Baños, P. I.

Philippine Islands. Bureau of Agriculture, Manila, P. I. *Report, Bulletin, Philippine Agricultural Review, Philippine Farmer.*

Phillippine Islands. Bureau of Science, Manila, P. I. *Philippine Journal of Science.*

*Physiological Researches, Baltimore, Md.

*Playground Association of America, New York, N. Y. *The Playground.*

Portici. R. Scuola Superiore di Agricoltura, Portici, Italy. *Annali.*

Portland Society of Natural History, Portland, Me. *Proceedings.*

Porto Rico. Department of Agriculture and Labor, San Juan, P. R. *Revista de Agricultura.*

Porto Rico, Department of Agriculture and Labor. Insular Experiment Station, Rio Piedras, P. R. *Bulletin, Circular Journal of Agriculture. Report.*

Preservation of Native Plants: see Society for the Protection of Native Plants.

§*Progressus Rei Botanicae, Jena, Germany.

Puget Sound Marine Station. Seattle, Wash. *Publications.*

Quarterly Journal of Forestry, London, Eng.

Quebec Society for the Protection of Plants, Quebec, Can. *Annual Report.*

‡Repertorium Novarum Specierum Regni Vegetabilis, Berlin, Germany.

Revista de la Facultad Nacional de Agronomia y Veterinaria, La Plata, Argentina.

*Revue de Géologie, Liége, Belgium.

†Revue Générale de Botanique, Paris, France.

*Rhodora, Boston, Mass.
Rio de Janeiro. Jardim Botanico, Rio de Janeiro, Brazil. *Archivos.*
Rio de Janeiro. Museu Nacional de Rio de Janeiro, Rio de Janeiro, Brazil. *Archivos.*
*Rivista di Patologia Vegetale, Pavia, Italy.
Rome, International Institute of Agriculture: see International Institute of Agriculture, Rome.
Rome. R. Istituto Botanico: see Annali di Botanica.
Royal English Arboricultural Society: see Quarterly Journal of Forestry.
Royal Gardens, Kew: see Kew, Royal Gardens.
Royal Horticultural Society: see London, Royal Horticultural Society.
Royal Microscopical Society: see London, Royal Microscopical Society.
St. Louis. Academy of Science, St. Louis, Mo. *Transactions.*
Santo Domingo. Secretary of Agriculture and Immigration, Santo Domingo, S. D. *Revista de Agriculture.*
Saone-et-Loire. Société des Sciences Naturelles de Saone-et-Loire, Chalon-sur-Saone, France. *Bulletin.*
Saõ Paulo. Museu Paulista, Saõ Paulo, Brazil. *Revista.*
Sapporo Natural History Society, Sapporo, Japan. *Transactions.*
Sapporo. Tohoku Imperial University, College of Agriculture, Sapporo, Japan. *Journal.*
Saragossa. Asociacion de Labradores de Zaragoza, Saragossa, Spain. *Boletin.*
Scafati. R. Istituto Sperimentale di Scafati, Salerno, Italy. *Bollettino Tecnico.*
Schweizerische Botanische Gesellschaft, Bern, Switzerland. *Berichte.*
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Scientific Monthly, Garrison, N. Y.
Selborne Magazine and Nature Notes, London, England.
Senckenbergische Naturforschende Gesellschaft: see Frankfurt.
Singapore. Botanic Gardens, Singapore, Straits Settlements. *Annual Report, Gardens' Bulletin.*
Smithsonian Institution, United States National Museum, Washington, D. C. *Report.*
Sociedad Cientifica "Antonio Alzate," Mexico, Mexico. *Memorias y Revista.*

Sociedad Cientifica Argentina, Buenos Aires, Argentina. *Anales.*

Sociedad Cubana de Historia Natural "Felipe Poey," Havana, Cuba. *Memorias.*

§Sociedad de Ciencias Naturales del Instituto de la Salle, Bogota, Colombia. *Boletin.*

Sociedade Broteriana, Jardim Botanico, Coimbra, Portugal. *Boletim.*

Sociedade Nacional de Agricultura, Rio de Janeiro, Brazil. *A Lavoura.*

‡Società Botanica Italiana, Florence, Italy. *Bullettino, Nuovo Giornale Botanico Italiano, Bulletino Bibliografico.*

Società di Naturalisti in Napoli, Naples, Italy. *Bollettino.*

Societas pro Fauna et Flora Fennica, Helsingfors, Finland. *Acta Meddelanden.*

Société Botanique de Lyon, Lyons, France. *Annales.*

Société Botanique Néerlandaise, Nijmegen, Holland. *Nederlandsch Kruidkungdig Archief, Recueil des Travaux botaniques Néerlandais.*

Société d'Histoire Naturelle de l'Afrique du Nord, Algiers, Algeria, *Bulletin.*

Société d'Histoire Naturelle de Macon, Macon, France. [*Publications.*]

Société des Naturalistes Luxembourgeois, Luxemburg, Grand Duché de Luxembourg. *Bulletins Mensuels.*

Société Scientifique d'Arcachon (Station Biologique), Arcachon, France. *Bulletin.*

§Société Vaudoise des Sciences Naturelles, Lausanne, Switzerland. *Bulletin.*

Society for Experimental Biology and Medicine, New York, N. Y. *Proceedings.*

Society for the Protection of Native Plants, Boston, Mass. *Leaflets.*

*Society for the Promotion of Agricultural Science. *Proceedings.*

Society of American Florists and Ornamental Horticulturists. *Proceedings.*

*Soil Science, Baltimore, Md.

§South Africa, Union of, Department of Agriculture, Pretoria, S. Africa. *Agricultural Journal.*

Southern California Academy of Sciences, Los Angeles, Cal. *Bulletin.*

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Stanford University, Cal. *Publications. University Series, Biological Science.*

Staten Island Association of Arts and Sciences, New Brighton, S. I., N. Y. *Proceedings, Museum Bulletin.*

Stockholm. Bergianska Trädgården: see Bergianska Trädgården.

Stockholm. Kongliga Vetenskaps-Akademien: see Sweden.

Stockholm. Statens Skögsforsöksanstalt, Stockholm, Sweden. *Meddelanden.*

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‡Svensk Botanisk Tidskrift, Stockholm, Sweden.

Sweden. Kongliga Svenska Vetenskaps-Akademien: see Arkiv för Botanik.

Sweden. Sveriges Utsädesförening, Svalöf, Sweden. *Tidskrift.*

Sydney Botanic Gardens, Sydney, New South Wales. *Report.*

Sydney. Technological Museum, Sydney, New South Wales. *Publications.*

Tasmania. Royal Society, Hobart, Tasmania. *Papers and Proceedings.*

The Botanical Society and Exchange List of the British Isles: see Botanical Society and Exchange List.

The Conservationist: see New York Conservation Commission.

The Cuba Review: see Cuba Review.

The Playground: see Playground Association of America.

The Scientific Monthly: see Scientific Monthly.

The Selborne Magazine and Nature Notes: see Selborne Magazine and Nature Notes.

Thuringischer Botanischer Verein, Weimar, Germany. *Mittheilungen.*

§Tiflis. Jardin Botanique, Tiflis, Russia. *Travaux, Moniteur, Seed Lists.*

‡Tokyo Botanical Society, Tokyo, Japan. *Botanical Magazine.*

Tokyo. Imperial University, College of Agriculture, Tokyo, Japan. *Journal.*

Toronto. University of Toronto, Canada. *Studies; Anatomical Series, Biological Series, Geological Series, Pathological Series, Physiological Series.*

Torrey Botanical Club, New York, N. Y. *Bulletin, Memoirs, Torreya.*

Trajectum: see Utrecht.

Trinidad. Agricultural Society of Trinidad and Tobago, Trinidad, W. I. *Proceedings.*

Trinity College, Dublin, Ireland. *Notes from the Botanical School.*

Tromsø Museum, Tromsø, Norway. *Aarshefter, Aarsberetning.*

Tucuman. Universidad de, Tucuman, Argentina. [*Publicaciones.*]

Union of South Africa: see South Africa, Union of South Africa.

United Empire: see London, Royal Colonial Institute.

United States Department of Agriculture, Washington, D. C. *All Publications.*

United States Geological Survey, Washington, D. C. *Bulletin, Annual Report, Monographs, Professional Papers.*

United States National Museum: see Smithsonian Institution, United States National Museum.

Upsala. Kgl. Universität, Upsala, Sweden. *Botanical Reprint, Seed Lists.*

Upsala. Regia Societas Scientiarum Upsaliensis, Upsala, Sweden. *Nova Acta.*

Utrecht. Hortus Botanicus Universitatis Rheno-Traiectinae, Utrecht, Holland. *Seed Lists.*

Vermont. Commissioner of Agriculture, Burlington, Vt. *Annual Report.*

Victoria. Department of Agriculture, Melbourne, Victoria. *Journal.*

Victoria. Field Naturalists' Club of Victoria, Melbourne, Australia. *The Victorian Naturalist.*

§*Vienna. K. K. Zoologisch-Botanische Gesellschaft, Vienna, Austria. *Abhandlungen.*

§‡Vienna. K. K. Zoologisch-Botanische Gesellschaft, Vienna, Austria. *Verhandlungen.*

Virginia Truck Experiment Station, Norfolk, Va. *Bulletin.*

Wageningen. Landbouwhoogeschool, Wageningen, Holland. *Mededeelingen.*

*Washington Academy of Sciences, Washington, D. C. *Journal.*

Washington. Biological Society of Washington, Washington, D. C. *Proceedings.*

Washington. Library of Congress, Washington, D. C. *Report.*
Wellcome Chemical Research Laboratories, London, England. *Papers.*
West Indies. Agricultural Department, Barbados, W. I. *Bulletin, Agricultural News.*
West Java. Proefstation voor Suikerriet: see Java, Proefstation.
Wild Flower Preservation Society of America, New York, N. Y. *Circulars.*
Wisconsin Academy of Arts and Sciences, Madison, Wis. *Transactions.*
Wisconsin. University of, Madison, Wis. *Bulletin, Science Series.*
Woman's National Farm and Garden Association, Chicago, Ill. *Farm and Garden.*
World Agriculture, Amherst, Mass.
*Zeitschrift für Botanik, Jena, Germany.
*Zeitschrift für induktive Abstammungs-und Vererbungslehre, Berlin, Germany.
§†Zeitschrift für Pflanzenkrankheiten, Stuttgart, Germany.
*Zeitschrift für Pflanzenzuchtung, Berlin, Germany.
*Zeitschrift für Physiologische Chemie, Strassburg, Germany.
*Zeitschrift für Wissenschaftliche Mikroskopie, Brunswick, Germany.
Zürich. Naturforschende Gesellschaft, Zürich, Switzerland. *Vierteljahrsschrift.*

REPORT OF THE HONORARY CURATOR OF MOSSES

DR. N. L. BRITTON: Director-in-Chief.

Sir: The accessions for the year 1921 number 2,539 and 2,021 duplicates have been distributed as exchanges. We have received some valuable collections from tropical American regions: Bahamas, Cuba, Hispaniola, Mexico, Guatemala, Panama, Trinidad, Venezuela, Colombia, and British and French Guiana. The American Museum of Natural History has sent the remaining duplicates of Dr. Hovey's collections in Greenland; the National

Herbarium in Washington has utilized our knowledge by sending many unnamed specimens for determination. Mr. Williams has studied a collection of mosses from the Frazer River region for the Geological Survey of Canada and his determination have been published in the Report of the Canadian Arctic Expedition 1913–18. He has also studied, for Yale University, a collection of 480 specimens from Michigan, made by Dr. Nichols, and made critical examinations for Mr. Holzinger's Musci Acrocarpi Boreali-Americani Exsiccatae fascicle 17, numbers 401–425. We have purchased from the Bureau of Science in Manila 170 Philippine specimens. The National Museum sent us a set of African mosses named by H. N. Dixon and Professor Brotherus has sent us 109 fromJapan. Professor Cockerell collected a few in Portugal and Madeira and Dr. Evans has sent in exchange a few from Java. We have received specimens for naming from Quebec; Maine, Vermont; Pennsylvania; North Carolina, Georgia, Alabama and Florida; Texas and Missouri; Minnesota and Michigan; Colorado, Idaho and Montana; Alaska and British Columbia.

The collection of lantern slides has been increased by 292 colored slides and 124 uncolored slides and 304 negatives have also been added.

Acting as secretary for the Stokes' Fund and the Wild Flower Preservation Society I have answered letters, distributed literature, and given several lectures to Garden Clubs in the vicinity of New York.

Respectfully submitted,

ELIZABETH G. BRITTON,

Honorary Curator of Mosses.

REPORT OF THE PALEOBOTANIST

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to report as follows upon paleobotanical activities during the year 1921.

During the period from January 1 to June 30 I was in Washington, D. C., engaged upon work on the fossil flora of Alaska for the U. S. Geological Survey. Since then work in connection with the Garden has occupied my entire time and attention.

A system of recording paleobotanical specimens by lot and accession numbers was inaugurated, in a suitable record book. At date fourteen lots, including 355 specimens, have been listed and each specimen marked with its lot number so that it may be readily identified if at any time misplaced. Three of these lots—from Siparia, Moruga, and Matchepoorie Hill, Trinidad—which include eighty-four specimens, collected by Mr. Gilbert Van Ingen, under your direction, in the early part of the year, have been accessioned as of the year 1921 and added to the Museum collections. Also one lot, from the Province of Bahia, Brazil, which includes 150 specimens, obtained through exchange, has been added.

A thorough revision was made of the exchange list of writers on paleobotanical subjects, and, in particular, systematic effort was made to effect a resumption of correspondence and exchange of publications with European authors with whom communication had been cut off or interrupted during the period of the war. Responses were received fron eleven American and fourteen foreign correspondents, and fifty-three separate paleobotanical publications have been received to date, from twenty-five different authors, and added to the library.

The principal investigational work has been prosecuted in connection with the fossil flora of the West Indies. Collections from Santo Domingo, Porto Rico, Cuba, and Trinidad were studied. Specimens suitable for description

and illustration were selected and seventy-one drawings of selected specimens were made. A general review of the fossil flora of the West Indies and an account of the work personally accomplished, and under way, was outlined at the Botanical Conference held at the Museum on November 2.

The four wall cases in the paleobotanical musuem that were more or less damaged during recent changes in the heating arrangements were repaired. The specimens contained in them were all cleaned, rearranged, and re-labeled where necessary. Seventy-five new labels were prepared and installed.

Several requests for identification of paleobotanical and supposed paleobotanical material were received, investigated and reported upon, which involved considerable research work and correspondence.

Respectfully submitted,

ARTHUR HOLLICK,

Paleobotanist.

SCHEDULE OF EXPENDITURES DURING THE YEAR 1921

I. CITY MAINTENANCE ACCOUNT

		Appropriated	Expended	Balance
Salaries, Regular Employees		$142,839.00	$142,525.62	$313.38
Wages, Temporary Employees		12,796.80	12,796.80	
Total, Personal Service		$155,635.80	$155,322.42	$313.38
Forage and Veterinary Supplies		$1,000.00	$999.64	$0.36
Fuel Supplies		29,700.00	29,698.65	$1.35
Office Supplies		400.00	399.93	0.07
General Plant Supplies		1,325.00	1,324.33	0.67
General Plant Equipment		1,000.00	993.45	6.55
General Plant Materials		2,557.00	2,556.69	0.31
General Repairs and Replacements	$8,000.00			
Contribution from the New York Botanical Garden to supplement available funds for repairs to central domeof Conservatory Range 1	400.00			
	$8,400.00	8,400.00	8,356.51	43.49
Light, Heat and Power		425.00	424.97	0.03
Shoeing and Boarding Horses, including Veterinary Service		200.00	199.50	0.50
Telephone Service		200.00	198.71	1.29
Total, Expenses other than Personal Service		$45,207.00	$45,152.38	$54.62
Summary, City Maintenance Account				
Total Allowance	$200,442.80			
Contributed by Garden	400.00	$200,842.80	$200,474.80	$368.00

2. SPECIAL GARDEN ACCOUNTS

	Appropriated	Expended	Balance
PLANT FUND			
Balance from 1920	*$295.54*		
Sale of Hay	302.40		
Total	$597.84	$574.08	$22.76

	Appropriated	Expended	Balance
SPECIAL BOOK FUND			
Balance from 1920	*$277.79*		
Contribution	7.00		
Sale of Books	110.00		
Total	$394.79	$376.36	$18.43
EXPLORATION FUND			
Balance from 1920	*$19.96*		$19.96
MUSEUM AND HERBARIUM FUND			
Balance from 1920	*$8.62*		
Contribution	40.00		
Total	$48.62	$40.00	$8.62
GUGGENHEIM GREENHOUSE FUND			
Balance from 1920	*$15.55*		
Transferred from Grounds Improvement Fund	58.98		
Transferred from Special Development Fund	128.39		
To balance error on Voucher 19207		$5.00	
To balance difference between Treasurer's and Appropriation Accounts		197.92	
	$202.92	$202.92	
GROUNDS IMPROVEMENT FUND			
Balance from 1920	*$58.98*		
Transferred to Guggenheim Greenhouse Fund		$58.98	
Total	$58.98	$58.98	
GARDEN SCHOOL FUND			
Balance from 1920	*$1,259.47*		
Federal Board for Vocational Education, Fees	2,081.13		
Salary, Supervisor of Gardening Instruction		$1,225.00	
Transferred to Special Development Fund		2,115.60	
Total	$3,340.60	$3,340.60	
SPECIAL DEVELOPMENT FUND			
Balance from 1920	*$2,897.57*		
Contributions	7,690.00		
Transferred from Garden School Fund	2,115.60		
Transferred from Mary J. Kingsland Fund	42.20		

	Appropriated	Expended	Balance
New Paths and Grading		$8,910.80	
Exploration and Collecting		379.18	
Plants for Grounds		498.80	
Construction Supplies		936.65	
Museum Cases		758.48	
U. S. Ensigns		25.00	
Transferred to Guggenheim Greenhouse Fund		128.39	
Total	$12,745.37	$11,637.30	$1,108.07
MARY J. KINGSLAND BEQUEST			
Balance from 1920	*$1,579.70*		
Gate-posts and Coping (Balance of Account)		$1,537.50	
Transferred to Special Development Fund		42.20	
Total	$1,579.70	$1,579.70	
LOUISE COMBE BEQUEST			
Construction of Mansion Approach Entrance and Fencing	$5,466.38		
Materials for Fence		$1,413.86	
Cast Stone Piers		3,250.00	
Architect's Fees		400.00	
Labor		338.00	
Total	$5,466.38	$5,401.86	$64.52

3. SPECIAL INCOME ACCOUNTS

	Appropriated	Expended	Balance
Income of Science and Education Fund			
Museum and Herbarium Specimens	$693.21	$693.21	
Apparatus	39.20	39.20	
Lectures	826.97	824.77	$2.20
Photography	105.47	105.47	
Exploration	1,000.00	1,000.00	
Investigation at other Institutions	450.15	450.15	
Total	$3,115.00	$3,112.80	$2.20
Income of Darius O. Mills Fund			
Lectures		$516.47	
Laboratories		187.08	
Museums		577.52	
Herbarium		584.35	
Library		233.85	
Total	$2,100.00	$2,099.27	$0.73

	Appropriated	Expended	Balance
Accumulated Income of the Henry Iden Fund			
Books	$700.00	$546.70	$153.30
Income of the William R. Sands Fund			
Horticultural Prizes	$400.00	$399.00	$1.00
Accumulated Income of the Olivia E. and Caroline Phelps Stokes Fund			
Preservation of Native Plants	$250.00	$106.85	$143.15
Accumulated Income of Students' Research Fund			
Aid for Students' Research	$700.00	$50.00	$650.00
Income of the David Lydig Fund			
Publications	$4,000.00	$3,998.80	$1.20
Income of the Addison Brown Fund			
Publication of Addisonia	$3,200.00	$2,860.05	$339.95
Income of John Innes Kane Fund			
Plants for Grounds	$500.00	$296.83	$203.17
Income of Maria DeWitt Jesup Fund			
Increase of the Collections, Books	$1,025.00	$907.54	$117.46
Accumulated Income of the Charles Budd Robinson Memorial Fund			
Aiding Exploration	$100.00		$100.00
Accumulated Income of the Russel Sage and Margaret Olivia Sage Memorial Fund			
Construction of Fence	$7,500.00	$7,207.60	$292.40
Labor	8,010.00	8,009.20	0.80
Herbarium Cases	2,000.00	1,950.25	49.75
Publication	5,500.00	5,434.85	65.15
Repairs and Renewals			
To supplement City Maintenance Account		400.00	
Other charges		2,456.55	
Total	2,900.00	2,856.55	43.45
Salaries	28,127.00	27,656.18	470.82
Supplies	6,705.00	6,697.41	7.59
Reimbursement of Permanent Funds	20,000.00		$20,000.00
Total	$80,742.00	$59,812.04	$20,929.96
Income of the Fanny Bridgham Fund			
Books and Book-binding	$1,200.00	$1,143.40	$56.60

4. GENERAL INCOME ACCOUNT

	Appropriated	Expended	Balance
Insurance	$1,000.00	$965.00	$35.00
Entertainment of Guests and Meetings of Members	1,460.00	1,456.02	3.98
Assistance for Treasurer	1,080.00	1,080.00	
Circulars for Membership	695.00	693.37	1.63
Temporary Subsidy for Addisonia	1,200.00	840.00	360.00
Addressograph	100.00	99.13	0.87
Contingent Fund	2,190.00	2,189.82	0.18
Salaries	11,855.00	11,377.70	477.30
Expenses of Honorary Curator of Economic Collection	600.00	600.00	
Expenses of Consulting Chemist	300.00	300.00	
Publications	1,200.00	1,119.04	80.96
Total	$21,680.00	$20,720.08	$959.92

SUMMARY OF EXPENDITURES FROM FUNDS OF THE GARDEN

Special Garden Accounts	$20,792.10
Special Income Accounts	75,333.28
General Income Account	20,720.08
Total	$116,845.46

5. BOARD ROOM FUND

January 1, 1921, Balance in cash		$205.38
Gross Receipts, January to December	$379.78	
Less—Credited to Garden Funds	14.23	
		365.55
Total Net Receipts		$570.93
Disbursements, Supplies	$161.77	
Contingencies	66.73	
		228.50
December 31, 1921, Balance in cash		$342.43

Respectfully submitted

WALTER S. GROESBECK,
Bookkeeper.

E. and O. E.
NEW YORK, JANUARY 9, 1922.

Director-in-Chief's Account for the Year 1921

New York, March 24, 1922

Mr. Robert W. de Forest,
Chairman Finance Committee, New York Botanical Garden,
30 Broad Street, New York, N. Y.

Dear Sir:

This is to certify that I have examined and audited the financial books and accounts of the Director-in-Chief of the New York Botanical Garden for the year nineteen hundred and twenty-one (1921), and that I find the same to be correct, and the cash balance to be as stated in the current cash book.

In accordance with recent practice, I have not included in the auditing the examination of the vouchers for City maintenance or construction work paid for by the City, as such vouchers have been found proper and in order by the City authorities, and it was decided in 1904 by the then Chairman of the Finance Committee that a further examination of them was unnecessary. By like authority I have omitted also a detailed examination of the annual membership dues account. These dues are received by the Director-in-Chief and forwarded by him to the Treasurer, the former keeping a detailed record of the same.

Respectfully submitted,

A. W. Stone,
Special Auditor.

REPORT OF THE CHAIRMAN OF THE SCIENTIFIC DIRECTORS TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN

The Scientific Directors have held their regular meetings throughout the year and have considered with the Director-in-Chief many of the various topics relating to the scientific and educational activities of the Garden, which are presented in detail in his report. We are glad to be able to report that in spite of increased cost the Garden has been able to conduct its various serial and other publications without essential impairment in their extent and in the quality of illustrative material.

The matter of the development and planting of the part of the Garden facing on Pelham Parkway has been taken up by a joint committee of the Women's Auxiliary and the Scientific Directors and it is hoped that this much needed improvement may be carried through as rapidly as is consistent with the nature of the work involved.

Progress is being made in the incorporation into the Herbarium of the accumulated materials relating to the *North American Flora* and very gratifying additions to our collections from South America in connection with the joint explorations conducted by the Garden, the National Herbarium at Washington, and the Gray Herbarium at Harvard have been made.

Respectfully submitted,

R. A. HARPER,

Chairman.

REPORT OF THE COMMITTEE ON PATRONS, FELLOWS AND MEMBERS FOR THE YEAR 1921.

To the Board of Managers of the New York Botanical Garden.

Gentlemen: The number of new members who have qualified is 123. The number of Annual members is now 1145; life members 128; sustaining members 13; fellowship members 2.

Of these 55 are now in arrears for dues for 1921, 13 for dues for 1920 and 1921, 9 for dues for 1919, 1920, and 1921.

Dues have been collected to the amount of $11,406.37.

One person has qualified as a life member by the payment of $250. These sums have been transmitted to the treasurer.

A complete list of all classes of members to date is herewith submitted.

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*D. O. Mills,
*J. Pierpont Morgan, Sr.
John D. Rockefeller,
*Mrs. Russell Sage,,
*Francis Lynde Stetson,
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*William E. Dodge,
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George J. Gould,
Edward S. Harkness,
*Mrs. Esther Herrman,
Archer M. Huntington,
*Henry Iden,
Mrs. John Innes Kane,
*John Stewart Kennedy,
*Mrs. Mary J. Kingsland,
*J. Pierpont Morgan, Sr.,
*Oswald Ottendorfer,

* Deceased.

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*William R. Sands,
*William C. Schermerhorn,
*James A. Scrymser,
Mrs. Finley J. Shepard,
*Samuel Sloan,
Mrs. Frederick F. Thompson,
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Dr. Robert W. de Forest,
Cleveland H. Dodge,
James B. Ford,
Daniel Guggenheim,
Murry Guggenheim,
S. R. Guggenheim,
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Ogden Mills,
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Mortimer L. Schiff,
Leon Schinasi
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R. N. Cranford,
Melville C. Day,
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* Deceased

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Miss Ethel DuBois,
Miss Katharine DuBois,
Wm. A. DuBois,
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William M. Lybrand,
J. M. Richardson Lyeth,
Miss Grace G. Lyman,
S. Ma,
Dr. John T. Mac Curdy,
C. K. MacFadden,
Clarence H. Mackay,
Kenneth K. Mackenzie,
Mrs. Charles F. MacLean,
Malcolm MacMartin,
V. Everit Macy,
F. Robert Mager,
J. H. Maghee,
Pierre Mali,
L. William Malone,
J. G. C. Mantle,
Miss Delia W. Marble,
John Markle,
Mrs. John Markle,
Alfred E. Marling,
Otto Maron,
Mrs. Henry Marquand,
Edwin S. Marston,
R. W. Martin,
Dr. Walton Martin,
William J. Matheson,
George O. May,
Harry Mayer,
Mrs. R. de L. Mayer,
Dr. D. H. McAlpin,
Geo. L. McAlpin,

George McAneny,
Mrs. Alfred McEwen,
Edward A. McIlhenny,
Henry P. McKenney,
John A. McKim,
W. A. McLaren,
Mrs. James McLean,
Edward F. McManus,
William McNair,
B. Frank Mebane,
Morton H. Meinhard,
Dr. Walter Mendleson,
Henry H. Merriam,
John L. Merrill,
William F. Meschenmoser,
Manton B. Metcalfe,
Herman A. Metz.
Eugene Meyer, Jr.,
John G. Milburn,
Miss Mary G. Millett,
Dr. Adelaide Mills,
Alex. S. Mitchell,
Mrs. John Murray Mitchell,
H. de La Montagne,
C. D. Montague,
Mrs. H. E. Montgomery,
Robert H. Montgomery,
Barrington Moore,
Clement Moore,
J. C. Moore,
Miss Katherine T. Moore,
Mrs. Paul Moore,
Victor Morawetz,
Miss Anne Morgan,
Miss C. L. Morgan,
E. D. Morgan,
Mrs. J. P. Morgan, Jr.,
Mrs. Pierpont Morgan,
Wm. Fellows Morgan,
Mrs. Dave Hennen Morris,
Dwight W. Morrow,
Mrs. James Moses,
Henry C. Mott,
Mrs. John B. Mott,
Eric Muelberger,
Frank J. Muhlfeld,
Edwin H. Mulford,
Carl Muller,
John P. Munn,
Frank A. Munsey,
Miss Adeliza Morton Murphy,
G. M. P. Murphy,
Fred A. Muschenheim,
William S. Myers,
Mme. Elie Nadelman,
Edward J. Nally,
National Association, Boards of Pharmacy,
A. G. Nesbitt,
Mrs. Russell H. Nevins,
Miss Edith Newbold,
Frederic R. Newbold,
William B. Nichols,
Mrs. William G. Nichols,
William H. Nichols,
Wm. Nilsson,
George Notman,
Howard Notman,
Miss Dorothy Oak,
George Washington Ochs Oakes
Percy J. O'Brien,
Mrs. Adolph Obrig,
Adolph S. Ochs,
John Offerman,
Mrs. Ponsonby Ogle,
P. M. Ohmeis,
E. E. Olcott,
Miss Mary Olcott,

Elam Ward Olney,
Robert Olyphant,
Mrs. Emerson Opdycke,
J. Oppenheim,
John B. O'Reilly,
William C. Orr,
Prof. Henry F. Osborn,
Mrs. William Church Osborn,
Homer S. Pace,
Miss Elizabeth H. Packard,
Fred'k. Page Co.,
Augustus G. Paine,
Henry Parish,
Junius Parker,
Winthrop Parker,
Chas. W. Parsons,
Mrs. Edgerton Parsons,
Miss Gertrude Parsons,
T. H. Hoge Patterson,
Mrs. Horace E. Payson,
Mrs. Charles A. Peacock,
Mrs. Frederick Pearson,
Charles E. Peck,
Dr. Charles H. Peck,
William Halsey Peck,
Mrs. Wheeler H. Peckham,
Dr. James Pedersen,
Mrs. Sarah G. T. Pell,
B. Henry Pelzer,
Edmund Penfold,
Miss Hattie W. Perkins,
Samuel T. Peters,
Mrs. Theodore Peters,
W. R. Peters,
Walter Peterson,
Carl Schurz Petrasch,
Curt G. Pfeiffer,
Arthur Pforzheimer,
Walter Pforzheimer,
Michael F. Phelan,
Henry Phipps,
Lloyd Phoenix,
Gottfried Piel,
Henry Clay Pierce,
Winslow S. Pierce,
Mrs. R. Stuyvesant Pierrepont,
J. Fred Pierson,
Mrs. Frank H. Platt,
John Platt,
Edward Plaut,
Miss R. A. Polhemus,
Miss Florence L. Pond,
Chas. Lane Poor,
Mrs. James Harper Poor,
James E. Pope,
Alexander J. Porter,
Mrs. Henry Kirke Porter,
Abram S. Post,
Miss Blanche Potter,
Mrs. Frank H. Potter,
Frederick Potter,
Fuller Potter,
Mrs. George D. Pratt,
Mrs. Herbert Lee Pratt,
John Pratt,
John T. Pratt,
Samuel Pratt,
Mrs. L. B. Preston,
Edgar S. Pretzfeld,
Miss Cornelia Prime,
R. L. Pritchard,
Mrs. Kate Davis Pulitzer,
H. St. Clair Putnam,
Miss Eva C. Putney,
Robert Pyle,
Percy R. Pyne,
Charles F. Quincy,
Samuel Raisler,

Stanley Ranger,
G. B. Raymond,
H. E. Raymond,
George W. Raynes,
Mrs. William A. Read,
Robert C. Ream,
Miss Emily Redmond,
Henry H. Reed,
John Reid,
Chas. Remsen,
William Rennult,
Samuel W. Reyburn,
Mrs. E. S. Reynal,
Thomas A. Reynolds,
Miss Elvine Richard,
Oscar L. Richard,
Eben Richards,
Ellis G. Richards,
E. O. Richards,
Max Richter,
Mrs. Robert Ridgway,
Wm. J. Riker,
Dr. A. I. Ringer,
Dr. Wm. C. Rives,
Miss Emeline Roach,
Mrs. Charles H. Roberts,
Miss G. Van B. Roberts,
Irving Bruce Roberts,
Miss Jennette Robertson,
Louis J. Robertson,
Andrew J. Robinson,
Mrs. Edward Robinson,
Mrs. John D. Rockefeller, Jr.,
William G. Rockefeller,
Nash Rockwood,
Albert J. Roe.
John Roger,
G. Vernor Rogers,
Hubert E. Rogers,
A. J. Rolle,
W. Emlen Roosevelt,
Mrs. W. Emlen Roosevelt,
Hon. Elihu Root,
Henry C. Ross.
Jacob Rossbach,
Peter W. Rouss,
W. A. Rowan,
C. H. Ruddock,
Louis Ruhl,
Justus Ruperti,
Jacob Ruppert,
Frederick K. Rupprecht,
Miss M. L. Russell,
John Barry Ryan,
Arthur Ryle,
Miss Julia Ryle,
Harry Sachs,
Samuel Sachs,
Clarence Sackett,
Mrs. Walter J. Salmon,
Mitchell Samuels,
Philip C. Samuels,
H. Sanhagen,
F. A. Sarg,
Miss G. W. Sargent,
Herbert L. Satterlee,
Mrs. Herbert L. Satterlee,
Mrs. Thomas E. Satterthwaite,
Oliver H. Sawyer,
Hermann Schaaf,
Fred'k Müller Schall,
Jacob Schapiro,
John Scheepers,
Anton Schefer,
Mrs. H. M. Schieffelin,
Dr. Wm. J. Schieffelin,
Charles A. Schieren,
Gustave H. Schiff,

Miss Jane E. Schmelzel,
D. Schnakenberg,
Henrich Schniewind, Jr.,
Carl Schoen,
W. D. Scholle,
Louis B. Schram,
Rudolph Schreiber,
Richard Schuster,
B. Schutz,
C. M. Schwab,
Gustav Schwab, Jr.,
Frederick Schwed,
Walter Scott,
Miss Grace Scoville,
Herbert Scoville,
Robert Scoville,
The Scoville School,
Mrs. Arthur H. Scribner,
Edward M. Scudder,
Alonzo B. See,
Prof. Edwin R. A. Seligman,
Mrs. Isaac N. Seligman,
Jefferson Seligman,
E. W. Sells,
Mrs. Charles H. Senff,
Frederick W. Senff,
Alfred Seton,
Mrs. William F. Sheehan,
Dr. William H. Sheldon,
Finley J. Shepard,
David Shiman,
S. W. Shipway,
George W. Short,
Frank R. Shull,
Hiram W. Sibley,
Mrs. J. Siegel,
Benjamin F. Simmons,
H. L. Simmons,
Alfred L. Simmon,
Franklin Simon,
Robert E. Simon,
Theodore A. Simon,
Francis Louis Slade,
Ralph E. Slaven,
Benson B. Sloan,
Samuel Sloan,
Thomas W. Slocum,
Thomas Smidt,
Daniel Smiley,
Charles R. Smith,
Miss Fanny A. Smith,
James B. Smith,
Nelson Smith
Pierre J. Smith,
B. E. Smythe,
Frederick Snare,
E. G. Snow,
Frederic A. Soldwedel,
Phineas Sondheim,
B. Souto,
William M. Spackman,
Mrs. Edward W. Sparrow,
Mrs. Gino C. Speranza,
Mrs. B. G. Spiegelberg,
Dr. Edward H. Squibb,
Mrs. Mary P. Eno Steffanson,
Fred. T. Steinway,
Wm. R. Steinway,
Olin J. Stephens,
Roderick Stephens,
Benjamin Stern,
Sereno Stetson,
Edward R. Stettinius,
Mrs. Byam K. Stevens,
Frederic W. Stevens,
Lispenard Stewart,
Chauncey Stillman,
Miss Clara F. Stillman,

C. C. Stillman,
Dr. D. M. Stimson,
Alfred W. Stone,
Mrs. Willard Straight,
Mrs. C. I. Stralem,
H. Grant Straus,
Mrs. Nathan Straus, Jr.,
Roger W. Straus,
Albert Strauss,
Frederick Strauss,
Martin Strauss,
Samuel Strauss,
Mrs. William Strauss,
W. H. Strawn,
Dr. George T. Strodl,
Mrs. Gustaf Stromberg,
Benj. Strong, Jr.,
John R. Strong,
Nat. C. Strong,
Richard A. Strong.
Mrs. Theron G. Strong,
Joseph Stroock,
Louis S. Stroock,
Duncan Struthers;
F. K. Sturgis,
Mrs. F. K. Sturgis,
Miss Victoria F. Sturmer,
Mrs. James Sullivan,
Mrs. J. Andrews Swan,
Miss Mary Taber,
Henry W. Taft,
E. T. H. Talmage,
Charles G. Taylor,
Henry R. Taylor,
Dr. Richard A. Taylor,
W. A. Taylor,
H. L. Terrell,
Charles T. Terry,
Mrs. John T. Terry,

Mrs. Hector W. Thomas,
Mrs. Howard L. Thomas,
Percival Thomas,
Loren Ogden Thompson,
L. S. Thompson,
William B. Thompson,
Dr. W. Gilman Thompson,
Samuel Thorne, Jr.,
Louis C. Tiffany,
Henry N. Tifft,
Dr. Walter Timme,
James Timpson,
Mrs. Norman E. Titus,
Rev. E. P. Tivnan, S. J.,
Mrs. Margaret T. Tjader,
J. Kennedy Tod,
Nesib Trabulsi,
Mrs. John B. Trevor,
A. F. Troescher,
John Trounstine,
E. Kellogg Trowbridge,
Carll Tucker,
Dr. Alfred Tuckerman,
Paul Tuckerman,
Edward Turnbull,
Mrs. Harold M. Turner,
Geo. E. Turnure,
Benjamin Tuska,
Mrs. Mary A Tuttle,
C. E. Tuttle,
Mrs. Alice B. Tweedy,
E. S. Twining,
Lucien H. Tyng,
August Uhl,
Oswald W. Uhl,
Mrs. Walter M. Underhill,
Mrs. Henry C. Valentine,
James J. Van Alen,
Mrs. Frederick T. Van Beuren,

Augustus Van Cortlandt,
Barend Van Gerbig,
John B. Van Haelen,
E. H. Van Ingen,
Gilbert Van Ingen,
Mrs. Harriet Van Ingen,
Dr. Philip Van Ingen,
Mrs. Warner M. Van Norden,
Mrs. E. Van Raalte,
Mrs. Wilbur Linwood Varian,
Mrs. James M. Varnum,
Mrs. A. C. Veatch,
Thos. F. Vietor,
Alfonso P. Villa,
G. B. Vitelli,
Ludwig Vogelstein,
Mrs. Owen M. Voight,
Dr. S. Wachsmann,
Harry Wacker,
Montgomery Waddell,
Mrs. J. Howard Wainwright,
Justus I. Wakelee,
William I. Walker,
Mrs. W. K. Wallbridge,
Leo Wallerstein,
Dr. Max Wallerstein,
Wm. I. Walter,
Artemus Ward,
C. Blaine Warner,
Mrs. Charles Howard Warren,
Mrs. John I. Waterbury,
C. W. Watson,
Mrs. J. E. Watson,
Mrs. E. H. Weatherbee,
Mrs. W. Seward Webb,
Miss Alice D. Weekes,
R. L. Wegel,
Dr. Eugene Wehmeyer,
George A. Weigel,
Charles H. Weigle,
Bernard Weining,
George W. Weiss,
Mrs. Samuel W. Weiss,
Mrs. John Wells,
Oliver J. Wells,
William Y. Wemple,
Arthur L. Wessell,
Dr. William West,
Miss Edith Wetmore,
Dr. Wm. E. Wheelock,
Miss Caroline White,
Harold T. White,
Clarence Whitman,
Howard Whittemore,
F. B. Wiborg,
Miss F. E. Wickham,
Henry Wigglesworth,
William G. Willcox,
Elmore A. Willets,
Mrs. Percy H. Williams,
Richard H. Williams,
William H. Williams,
W. P. Willis,
James R. Williston,
Frank D. Wilsey,
Prof. Edmund B. Wilson,
Dr. Margaret B. Wilson,
M. Orme Wilson,
Charles A. Wimpfheimer,
Harold Wingate,
Bronson Winthrop,
Grenville L. Winthrop,
Mrs. Robt. Winthrop,
Mrs. Frank S. Witherbee,
Joseph Wittmann,
Fred R. Wolff,
Lewis S. Wolff,
M. Wolff,

Mrs. T. Wolfson,
Mrs. William H. Woodin,
Prof. R. S. Woodward,
Miss Julia Wray,
Mrs. J. Hood Wright,
Dr. Peter B. Wyckoff,
Dr. George A. Wyeth,
Mrs. A. Murray Young,
George A. Zabriskie,
Henry C. Zaro,
Mrs. Anna M. von Zedlitz,
Charles H. Zehnder,
August Zinsser,
Charles Zoller,
Henry Zuckerman,

Members of the Women's Auxiliary

Mrs. George A. Armour,
Mrs. Robert Bacon,
Miss Elizabeth Billings,
Mrs. N. L. Britton,
Mrs. Charles D. Dickey,
Mrs. A. Barton Hepburn,
Mrs. Robert C. Hill,
Mrs. Walter Jennings,
Mrs. Delancey Kane,
Mrs. Hamilton F. Kean,
Mrs. Gustav E. Kissel,
Mrs. A. A. Low,
Mrs. V. Everit Macy,
Mrs. Henry Marquand,
Mrs. George W. Perkins,
Mrs. George D. Pratt,
Mrs. Harold I. Pratt,
Mrs. James Roosevelt,
Mrs. Benson B. Sloan,
Mrs. Theron G. Strong,
Mrs. Henry O. Taylor,
Mrs. W. Gilman Thompson,
Mrs, George Cabot Ward.

Honorary Members of the Women's Auxiliary

Mrs. E. Henry Harriman,
Mrs. John I. Kane,
Mrs. James A. Scrymser,
Miss Olivia E. P. Stokes,
Mrs. F. K. Sturgis,
Mrs. F F. Thompson,

REPORT OF THE TREASURER

NEW YORK, January 9, 1922

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: Herewith I submit a statement of my Receipts and Disbursements during the year 1921, and Balance Sheet from my Ledger as of December 31, 1921.

Respectfully submitted,

JOHN L. MERRILL,
Treasurer.

RECEIPTS AND DISBURSEMENTS

Receipts

Balance, January 1, 1921		$46,445.17
Legacies		
Francis Lynde Stetson	$25,000.00	
Emma Jones	1,000.00	$26,000.00
Special Trust Fund		
C. P. Daly		$19,807.81
Special Funds		
Special Book Fund		
Contributions	$7.00	
Sale of Books	110.00	$117.00
Special Development Fund, contributions	7,690.00	
Students' Research Fund, tuition fees	64.00	
Convalescent Soldiers' Gardening Fund, contributions	2,081.13	
Museum and Herbarium Fund, contribution	40.00	
Plant Fund, sale of hay	302.40	$10,294.53

Investment Account		
Russell Sage and Margaret Olivia Sage Memorial Fund, proceeds sale of		
100 shares Balto. & Ohio Ry. Co. Common.....	$4,079.00	
100 shares St. Louis SW. Ry. Co. Common.....	2,904.00	
200 shares St. Louis SW. Ry. Co. Pfd...	7,758.00	
$260,000 U. S. Govt. Victory Bonds.....	259,493.50	$274,234.50
General Income Account		
General Investments, proceeds sale of		
$35,000 Nor. Pac. R. R. Bonds, Gt. Nor. C. B. & Q. 4's.....	$35,000.00	
$33,000 U. S. Govt. Victory Bonds.....	32,966.17	$67,966.17 $342,200.67
Endowment Fund		
Life Membership Fee.....		$250.00.
Special Income Accounts		
Income of the David Lydig Fund, subscriptions to "North American Flora" and sales of publications.....	$3,590.71	
Income of the Addison Brown Fund, subscriptions to "Addisonia"...	2,352.25	
Income of the Sage Fund, from investments.....	25,759.02	
Income of the Stokes Fund, sales of leaflets.....	10.30	
Income of the Science and Education Fund, refund.....	182.39	$31,894.67

Sundry Accounts			
Income from Investments.		$23,318.40	
Director-in-Chief, working fund. . . .		10,000.00	
City Maintenance Account.		166,339.49	$199,657.89
General Income Account			
Fellowship Members, Dues.	$200.00		
Sustaining Members, Dues,.	350.00		
Annual Members, Dues.	10,826.37		$11,376.37
Sales of Merchandise and refunds.	88.75		
Interest on Deposits. . . .	979.73	$1,068.48	$12,444.85

Disbursements

Investment Accounts

Russell Sage and Margaret Olivia Sage Memorial Fund, purchase of	
$15,000. Michigan Central Ry.	$15,193.50
10,000. New York Central Ry.	10,163.02
15,000. Chicago & No. Western Ry.	15,228.49
15,000. Southern Ry .	11,962.50
15,000. Illinois Central Ry.	15,211.49
15,000. Atlantic Coast Line Ry.	12,112.50
15,000. Union Pacific Ry.	12,637.50
15,000. Chic. Burl. and Quincy Ry. . . .	12,112.50
15,000. Norfolk and Western Ry.	12,037.50

15,000.	New York Central Ry.	11,212.50
10,000.	Pacific Gas & Elect. Co.	8,925.00
10,000.	Illinois Central Ry.	10,128.08
10,000.	Chicago and No. Western Ry . .	10,151.50
10,000.	Pittsburgh, McK. and Young. Ry.	10,151.50
10,000.	Nash. Chat. and St. Louis Ry. . .	10,162.24
10,000.	Cin. New Orleans and Texas Pac. Ry.	10,181.97
10,000.	New York Telephone Co.	10,040.00
10,000.	Amer. Smelting and Ref. Co. . . .	8,681.25
10,000.	General Electric Co.	9,676.25
20,000.	Louis. and Nash. Ry.	20,302.63
20,000.	Atlantic Coast Line Ry.	20,363.64 $256,635.56

Sundry Accounts

Purchase of

$35,000.	Great Northern Ry. 7's.	$33,775.00
25,000.	Provident Loan Ctfs.	25,000.00
1,000.	New York City 4¼'s.	990.00
9,000.	New York City 4's.	8,718.75
10,000.	Niagara Falls Power.	9,550.00

5,000. Nash. Chat. and St. Louis Eq. 6's...	5,069.85	
5,000. Cin. New Orleans & Texas Ry. 6's ..	5,086.02	
Adjustments of Interest on purchase of Bonds	2,258.13	$90,447.75 $347,083.31

Special Garden Accounts, Vouchers Paid

Louisa Combe Bequest.....	$5,241.86	
Convalescent Soldiers Gardening Fund.....	1,701.90	
Special Development Fund.....	12,600.27	
Mary J. Kingsland Bequest.....	3,657.00	
Plant Fund.....	521.77	
Special Book Fund.....	568.36	$24,291.16

Special Income Accounts

Income of Sage Fund,		
Adjustments of Interest on Purchase of Bonds...	$4,439.98	
Vouchers Paid.....	65,532.62	$69,972.60
Vouchers Paid		
Income of the David Lydig Fund.....	$4,145.65	
Income of John Innes Kane Fund.....	372.22	
Income of Henry Iden Fund.....	1,041.69	
Income of Science & Education Fund.....	2,868.30	
Income of Jesup Fund..	515.00	
Income of William R. Sands Fund.....	415.00	
Income of Stokes Fund	64.54	
Income of Darius O. Mills Fund.....	1,747.55	
Income of Addison Brown Fund.....	2,980.42	

Income of Students Research Fund.....	25.00		
Income of Fanny R. Bridgham Fund.....	1,124.40	$15,300.58	$85,273.18

Sundry Accounts

Income of General Fund, Vouchers Paid.....	$20,362.73
City Maintenance Account, Vouchers Paid.....	166,339.49
C. P. Daly Fund.....	171.47
Balance, December 31, 1921.....	45,474.25

LEDGER BALANCES, DECEMBER 31, 1921

Permanent Funds	*Debit*	*Credit*
Endowment Fund.....		$269,260.00
Science & Education Fund.....		83,461.90
* Russell Sage and Margaret Olivia Sage Fund...		500,000.00
David Lydig Fund.....		34,337.86
Fanny R. Bridgham Fund.....		30,000.00
William R. Sands Fund.....		10,000.00
Darius O. Mills Fund.....		50,000.00
Henry Iden Fund.....		10,000.00
Addison Brown Fund.....		21,850.00
John Innes Kane Fund.....		10,000.00
Stokes Fund.....		3,000.00
Charles Budd Robinson Memorial Fund.....		705.94
Students Research Fund.....		4,360.00
Maria DeWitt Jesup Fund.....		25,000.00
Charles P. Daly Trust Fund.....		19,636.34
Francis Lynde Stetson Fund.....		25,000.00

General Investments

$50,000 Ches. & Ohio Ry. 4½'s.....	$47,875.00	
$50,000 Southern Ry 5's	54,604.17	
$50,000 Erie Ry. 4's....	46,145.84	
$59,000 Erie Ry. 4's....	54,713.75	
$24,000 U. S. Govt. 2nd Liberty Loan Bonds 4¼'s.....	24,060.00	
$50,000 Reading Ry. 4's	46,750.00	

* See Foot-note, p. 100.

	Debit	Credit
$10,000 New York City 4's	9,936.25	
$50,000 Penn. Ry. 4½'s	50,500.00	
$10,000 New York Cent. Ry	9,510.48	
$10,000 Balto. & Ohio Ry. 5's	10,025.00	
$11,000 Milw. Sparta & N. W. Ry. 4's	10,120.00	
$37,000 Nor. Pac. Ry. 4's	34,058.75	
$10,000 Third Liberty Loan	10,000.00	
$35,000 Great Nor. Ry. 7's	33,775.00	
$25,000 Provident Loan Soc. Ctfs	25,000.00	
$1,000 New York City 4¼'s	990.00	
$9.000 New York City 4's	8,718.75	
$10,000 Niagara Falls Power Co	9,550.00	
$5,000 Nash. Chat. & St. Louis Ry. Equip. 6's	5,069.85	
$5,000 Cin. N. O. & Texas Ry. Equip. 6's	5,086.02	$496,488.86
Temporary Investments		$300.11
Investment of Russell Sage and Margaret Olivia Sage Memorial Fund		
Stocks		
52 shares Bankers Trust Co	$19,500.00	
200 shares Manhattan Ry. Co	9,125.00	
250 shares U. S. Steel Corp. Pfd	27,359.37	
10 shares Importers & Traders Natl. Bk.	5,600.00	

400 shares American Tel. & Tel. Co.	37,775.00
200 shares A. T. & SF. Ry. Co. Pfd.	14,525.00
300 shares Missouri Pacific Common. . .	7,068.75
100 shares M. K. & T. Ry. Pfd.	1,200.00
100 shares Wabash Ry. Co. Common.	800.00
100 shares Wabash Ry. Co. Pfd. "A" . . .	2,262.50
100 shares Amer. Tel. & Tel. Cable Co. . .	5,075.00
100 shares Balto. & Ohio Ry. Co. Pfd.	4,400.00
100 shares Union Pac. Ry. Pfd.	6,237.50
Bonds	
$10,000 Ore. Washn. R. R. & Nav.	6,500.00
$19,000 N. Y. Telephone Co. Gen.	14,155.00
$17,000 Mo. Pacific Gen. 4's.	8,755.00
$6,000 Erie Ry. Cons. 4's	3,015.00
$6,000 Balto. & Ohio, 3½'s.	4,860.00
$7,000 Centr. New. Engl. 4's.	3,675.00
$7,000 Washn. Term. 3½'s.	4,830.00
$6,000 Manhattan Ry. Co. Cons. 4's.	3,120.00
$15,000 Mich. Central Ry	15,193.50
$10,000 N. Y. Central Ry	10,163.02
$15,000 Chic. & No. Wn. Ry.	15,228.49
$15,000 Southern Ry. Co.	11,962.50

$15,000 Illinois Central Ry.	15,211.49	
$15,000 Atlantic Coast Line Ry.	12,112.50	
$15,000 Union Pacific Ry	12,637.50	
$15,000 Chic. Burl. & Quincy Ry.	12,112.50	
$15,000 Norfolk & Western Ry.	12,037.50	
$15,000 N. Y. Central Ry. Co.	11,212.50	
$10,000 Pac. Gas & Electric Co.	8,925.00	
$10,000 Illinois Central Ry.	10,128.08	
$10,000 Chic. & No. Wn. Ry.	10,151.50	
10,000 Pitts. McK. & You Ry.	10,151.50	
$10.000 Nash. Chatt. & St. Louis Ry.	10,162.24	
$10,000 Cin. N. Or. & Tex. Pac. Ry.	10,181.97	
$10,000 N. Y. Telephone Co.	10,040.00	
$10,000 General Electric Co.	9,676.25	
$10,000 Amer. Smelt. & Ref. Co.	8,681.25	
$20,000 Louisville & Nashville R. R. Co.	20,302.63	
$20,000 Atlantic Coast Line Ry.	20,363.64	$446,473.68

Profit and Loss on Investments

(to be added to principal of funds)	$17,723.78

Income Accounts

Income of Stokes Fund	$314.51
Income of Students' Research Fund	843.68

Income of John Innes Kane Fund		526.48
Income of Charles Budd Robinson Memorial Fund		97.62
Income of Maria DeWitt Jesup Fund		620.24
Income of Darius O. Mills Fund		161.00
Income of Science and Education Fund		499.91
Income of Addison Brown Fund		30.06
Income of David Lydig Fund	$3,787.93	
Income of Henry Iden Fund	659.98	
Income of William R. Sands Fund	33.29	
*Income of Russell Sage and Margaret Olivia Sage Fund	60,451.26	
Income of Fanny R. Bridgham Fund		20.73
General Income	27,293.64	
Temporary Funds		
Louisa Combe Bequest		$143.74
Museum and Herbarium Fund		48.62
Special Development Fund		3,405.47
Special Book Fund		42.59
Plant Fund		272.67
Exploration Fund		19.96
Reserve Fund	$12,020.32	
Emma C. Jones Legacy		1,000.00
Director-in-Chief, working fund	30,000.00	
Cash Balance	45,474.25	
	1,122,683.21	$1,122,683.21

*Of the $500,000. credited to the Margaret Olivia Sage Fund, it is probable that over $60,000. of this amount is creditable to income, and this will offset the debit balance of $60,451.26 standing charged to "Income of Margaret Olivia Sage Fund." No definite computation can be made until the final accounting of Mrs. Sage's bequest is made, inasmuch as interest is and has been accumulating upon it since the time of her death, and only a part of the legacy has been received from her executors.

Treasurer's Account for the Year 1921

New York, March 24, 1922

Mr. Robert W. de Forest,
Chairman Finance Committee, New York Botanical Garden,
30 Broad Street, New York, N. Y.

Dear Sir:

This is to certify that I have, by direction of the Board of Managers, examined the books and accounts of the Treasurer of the New York Botanical Garden, for the year nineteen hundred and twenty-one (1921), together with their proper vouchers, and that I find the balance sheet and the Treasurer's statement of receipts and disbursements attached hereto to be correct.

The various investment securities have also been verified and accounted for, and I certify that the statement of the same reported in the balance sheet as of December 31, 1921, is correct.

Respectfully submitted,

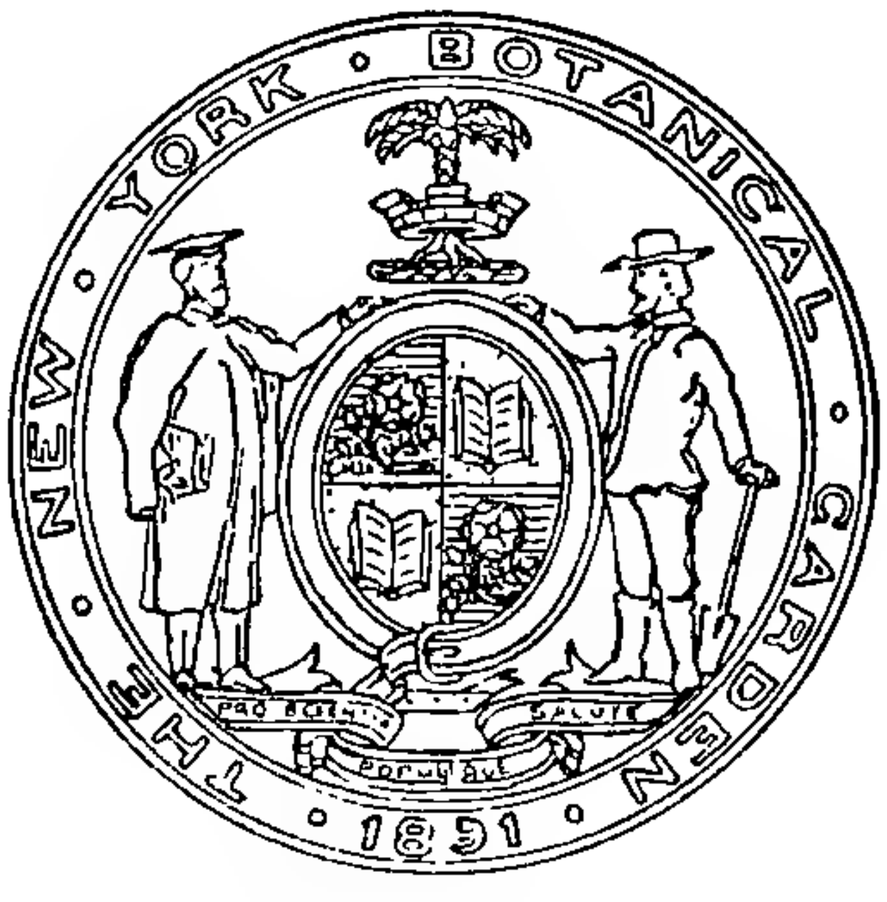
A. W. Stone,
Special Auditor.

VOL. 12 NO. 43

BULLETIN

OF

THE NEW YORK BOTANICAL GARDEN



ISSUED JUNE 7, 1923

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BULLETIN
OF
The New York Botanical Garden

Vol. 13 No. 43

REPORT OF THE SECRETARY AND DIRECTOR-IN-CHIEF FOR THE YEAR 1922

(*Accepted and ordered printed January 8, 1923.*)

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: I have the honor to submit my report for the year ending January 8, 1923.

Continued progress has been made in the improvement of the grounds, in the increase, development and study of the collections of plants, specimens and books and in our educational and scientific work. The beauty of the natural features of the reservation has been maintained, but both these and the plantations are becoming endangered by increasing numbers of visitors with insufficient police supervision. All the older plantations have been maintained, but some of them imperfectly, owing to the insufficient number of laborers and gardeners. Increasing public appreciation of plants of all kinds whether from the standpoint of usefulness or of beauty is evident, and the fundamental importance of vegetation to the welfare of the human race is attaining wider and wider recognition.

The institution has reached a high degree of development and of national and international reputation and significance. Its collections are among the largest and most important anywhere; their extended usefulness and increase, the further development of the reservation of nearly 400 acres of land, the completion of its buildings,

and the extension of educational and scientific work require more funds than have as yet been made available.

Plants and Planting

Approximately 16,000 kinds of plants have been in cultivation during the year, of which about 9,000 kinds were under glass and 7,000 kinds in the out-of-door plantations. The increase of about 1,000 kinds over the record of 1921, is mostly due to additional horticultural races and varieties in the special plantations, notably in the Iris Garden in cooperation with the American Iris Society and in the new Rock Garden, but some additions have been made throughout the collections. Mrs. Mortimer J. Fox and Mr. T. A. Havemeyer continued their aid in increasing the collection of lilies, and Mr. Havemeyer also contributed a valuable series of lilacs. In continued cooperation with the Horticultural Society of New York, Messrs. Bobbink and Atkins gave 2,700 plants for the Rose Garden, largely replacements.

The proper labelling of these vast collections has come to require more help for the Head Gardener than we have been able to give him, and it is very desirable that an additional assistant be provided. In many cases long study is necessary to determine if plants are true to name when received or grown from seed, requiring reference to the library and close comparison with herbarium specimens.

Very interesting and detailed accounts of horticultural and gardening operations are contained in the report of the Head Gardener, hereto appended.

The new Rock Garden. Under the direction of Dr. E. B. Southwick, Custodian of the Herbaceous Grounds, and largely by his personal labor, the large new rock garden near the Horticultural Gardens Entrance is rapidly assuming a completed form. This has required the assembling of a great number of boulders and other pieces of rock, which have been hauled to the site from time to time from various

parts of the grounds where they were not needed; also large quantities of gravel, sand and top soil have been used in the construction, which it is planned to complete during 1923. Dr. Southwick has already planted over 400 kinds of plants, including over 5,000 individuals, in this rock garden and he is propagating many more for planting during the coming season. Rock-loving plants being mostly small a very large number of species may be brought into a relatively small area.

As yet, the water-supply for the rock garden is insufficient; it will ultimately be necessary to give it greater head and volume by new water-pipes laid for several hundred feet through the Herbaceous Garden valley, to replace small pipes laid there some twenty years ago.

The Cactus collection. Much rearrangement of the extensive series of cactus plants in the greenhouses was made in the autumn, at about the time that the third volume of the monograph of the Cactus Family, written by Dr. J. N. Rose and myself, was published by the Carnegie Institution of Washington. Copies of this volume, as previously of the first and second volumes, have generously been sent by the Carnegie Institution to members of the Board of Managers; the fourth volume, to complete the work, is now going to the printers.

In order to obtain better conditions of cultivation we transferred the forest-inhabiting, moisture-needing cacti from Range 1 to Range 2, leaving most of the desert cacti in Range 1; several hundred plants which had hitherto been grown only in the propagating houses were moved into Range 1 and Range 2, thus greatly increasing the number of species in the public conservatories; display labels are now being made for both series.

The Orchid collection. The tropical and subtropical orchids now occupy one of the greenhouses at Conservatory Range No. 2, built by the generous gifts of $50,000 each made by Messrs. Daniel Guggenheim and Murry Guggen-

heim in 1918, and one-half of an adjacent greenhouse. The collection has become large and representative, there being 2,730 plants, including 834 species and varieties, but we have many desiderata. The number of plants which flowered during the past year was about 450. January and May were the two best months, with February and November not far behind. As many as 50 kinds in flower were exhibited together in January, and a similar display kept up during the early months of the year.

Development of the Southern part of the Reservation

Much progress was made during the year in the improvement and development of the southern part of the Garden reservation along Pelham Parkway, under the direction of the joint committees of the Scientific Directors and of the Women's Auxiliary previously appointed. Work was prosecuted at two areas. One of these lies east of the Mansion Approach Entrance, where about 350 lineal feet of the boundary wall and fence were completely built, grading and drainage completed, about 900 lineal feet of the path system partly built and may be completed during the winter, and the lilac collection largely increased. The other area lies between the Iris Garden Entrance and the Bronx River, where some 400 lineal feet of the boundary wall and fence, including piers for the Hemlock Grove path entrance (built from the bequest of Emma Chambers Jones), and the grading and drainage were completed, some 400 lineal feet of the path-system partly built, for completion during the winter, and a screen of trees planted. This constructon work was made possible by the aid of the Special Development Fund of 1922, subscribed by members as follows:

Dr. Robert Abbe	$25
Mr. Fritz Achelis	100
Mr. Edward D. Adams	250
Mrs. George A. Armour	50
Mr. Vincent Astor	100

Mrs. Robert Bacon	50
Mr. Henry de Forest Baldwin	100
Mr. E. P. Bicknell	25
Miss Elizabeth Billings	25
Mr. George Blumenthal	50
Mr. George S. Brewster	200
Dr. N. L. Britton	100
Mrs. Andrew Carnegie	250
Mr. C. A. Coffin	50
Mr. William Colgate	10
Mr. James W. Cromwell	200
Mr. Charles Deering	500
Mrs. Charles D. Dickey	50
Mr. Cleveland H. Dodge	100
Mr. Henry W. de Forest	250
Dr. Robert W. de Forest	100
Mr. Daniel Guggenheim	500
Mr. J. Horace Harding	100
Mr. J. Montgomery Hare	25
Mr. Edward S. Harkness	1,000
Mrs. E. H. Harriman	100
Mr. T. A. Havemeyer	50
Mr. Bernhard Hoffman	100
Mr. Adrian Iselin	50
Mr. Walter Jennings	100
Mrs. Delancey Kane	50
Mrs. John Innes Kane	200
Mrs. Gustav E. Kissel	25
Mr. Edward V. Z. Lane	100
Prof. Frederic S. Lee	100
Mr. Adolph Lewisohn	100
Mr. William J. Matheson	100
Hon. Ogden L. Mills	100
Mr. J. P. Morgan	500
Dr. Lewis R. Morris	250
Mr. Frederic R. Newbold	25
Mr. E. E. Olcott	10
Mr. Charles Lathrop Pack	50
Mrs. George W. Perkins	100
Mrs. George D. Pratt	100
Mrs. Harold I. Pratt	100
Mrs. William A. Read	25
Mrs. James Roosevelt	100
Mr. Mortimer L. Schiff	100
Mrs. James A. Scrymser	500
Mrs. Benson B. Sloan	25
Mr. William Sloane	100
Mr. Frederick Strauss	25

Mrs. Theron G. Strong	50
Mr. F. K. Sturgis	250
Mrs. Henry O. Taylor	200
Mrs. F. F. Thompson	100
Mr. Louis C. Tiffany	100
Mr. Felix M. Warburg	100
Mr. Allen Wardwell	25
Total	$8,220

Provision has been made in the budget for 1923 for continuing this work of fencing, grading, path-building and planting; it is highly important that it be pushed to completion as rapidly as funds can be made available; about one-third of the planned improvement has now been accomplished.

Museums and Herbarium

Progress was made in arranging and classifying many thousand specimens and incorporating them into the permanent collections; many thousand others remain in storage and additional museum aids are needed to enable our curators to select, classify and incorporate such of these as it is desirable to keep. Additional herbarium cases are also required for the proper arrangement of these collections for reference by students. From all sources, by gift, purchase, exchange and the collections by our expeditions, the report of the Head Curator records the receipt of over 60,000 specimens.

The most extensive single collection obtained was the herbarium of seaweeds brought together by the late Mr. Frank S. Collins, of Massachusetts, including over 41,000 specimens.* Dr. Howe has arranged and incorporated about one-third of this collection, which notably increases our reference strength in this class of plants.

Another notable accession has been made for us by Captain Arthur W. Hill, Director of the Royal Botanic Gardens at Kew, England, by permitting us to secure a

* Journ N. Y. Bot. Gard. **23**: 23, 24. 1922.

very valuable set of the botanical collections made by Edouard André in Colombia, Ecuador and Peru, estimated to include over 4,000 specimens and including many species not represented in American museums. The collection is of especial interest and value to us at this time, in connection with our investigations of the flora and plant products of northern South America; it was purchased from the income of the Maria DeWitt Jesup Fund.

From M. Lecompte, Director, we have received from the herbarium of the Jardin des Plantes, Paris, a highly valued series of over 1,000 specimens in continuation of exchanges, many of them from French Guiana.

The Library

The report of the Librarian shows an addition during the year of 504 bound volumes to the collection of books, which now consists of a little over 31,000 bound volumes. The additions have been made through exchanges of our publications for those of other institutions and societies, through gifts of books, and through purchases from the incomes of the Fanny R. Bridgham Fund and the Francis L. Stetson Fund. An additional card catalogue case was purchased from the income of the Sage Fund.

During the coming year purchases of books may for the most part be made only by means of funds subscribed, inasmuch as the incomes of funds used this year are now required for other purposes. Many books in the collection require binding or rebinding and some additional shelving is needed. This library has become one of the most important collections of botanical and horticultural literature in the world.

A suggestion of provision for the photostatic method for the facsimile reproduction of rare books and pamphlets made by Dr. Barnhart in his report as Bibliographer is important and will be brought to the attention of the Scientific Directors.

Botanical Exploration and Collecting

A joint expedition to the Andes of Colombia was organized in the spring under the leadership of Dr. Francis W. Pennell, now Curator of Botany at the Philadelphia Academy of Natural Sciences, formerly one of our associate curators; he was accompanied by Mrs. Pennell, by Mr. E. P. Killip of the United States National Museum and for part of the season by Professor Tracy E. Hazen of Barnard College; return was made in the autumn. Financial aid was given by us, by the Gray Herbarium of Harvard University, by the Smithsonian Institution, and by Mr. Oakes Ames. Very large collections of herbarium and museum specimens were obtained, and are being classified and arranged under Dr. Pennell's direction at Philadelphia, for distribution to the cooperating institutions. The results will form a noteworthy addition to knowledge of the flora of northern South America.

We also cooperated with the Smithsonian Institution and the Gray Herbarium in making arrangements for Mr. Paul C. Standley's expedition* to Salvador and Guatemala from December, 1921, to June, 1922, undertaken and successfully carried out, to increase knowledge and the representation of the vegetation of those countries in the collections of the cooperating institutions and to make more complete the descriptive Flora of Central America and Panama which Mr. Standley is now writing.

Dr. Henry H. Rusby, Honorary Curator of our Economic Collections, who led the Mulford Biological Exploring Expedition of 1921–1922 to Bolivia, returned in the spring with a large and important series of museum and herbarium specimens, a set of which has been selected by him for the collections of the Garden and partly studied. He has published a narrative of his trip† and his annual report, hereto appended, gives additional details of his work.

* Journ. N. Y. Bot. Gard. **23**: 168–175 1922.
† Journ. N. Y. Bot. Gard. 23: 101–112. 1922.

Accompanied and aided by Mrs. Britton and by Miss Margaret S. Brown, I was in Porto Rico for a little over two months in the early part of the year,* engaged in collecting specimens and obtaining information concerning plants and their products, for use in the Descriptive Flora of Porto Rico and the Virgin Islands, publication of which is now being commenced by the New York Academy of Sciences, as the botanical part of the scientific survey of these United States insular possessions.

Dr. John K. Small, Head Curator, has continued botanical collecting in Florida by means of continued aid from Mr. Charles Deering, and has greatly increased our collections of living plants from that state as well as of herbarium and museum specimens. He made a noteworthy collection of all the known kinds of cactuses of the southeastern United States which we have put on exhibition in Conservatory Range No. 2.

Rev. Dr. Herbert M. Denslow, Honorary Custodian of the Local Herbarium, made collections of specimens desired in southern New York, northern New Jersey and Connecticut. His report is appended.

Public Instruction and Information

Educational work has been continued along all the lines followed in previous years. Much progress was made in labeling plants throughout the grounds and in the museums, but many plants and specimens still require labels and is hoped to supply several thousand more during the coming year. Public lectures on Saturday and Sunday afternoons have been continued either in the Museum Building or in the Central Display Greenhouse, a winter course in the greenhouse having been arranged for the first time. Members of the staff, acting as docents, have given out a great amount of information to visiting parties and individuals; we did not succeed in concentrating this

* Journ. N. Y. Bot. Gard. **23**: 49–59. 1922.

docentry work with one person, an arrangement which I suggested as desirable in my last annual report. The great number of inquiries made by visitors and by letters have been answered, in many cases requiring much investigation to get the information desired.

The Hemlock Grove

The natural forest which clothes the rocky ridges bordering the Bronx River in the central part of the Garden reservation, characterized by an abundant and vigorous growth of the hemlock spruce at its most southern range along the Atlantic Coast, has always been one of the most attractive and interesting features of Bronx Park, both summer and winter, and special care has been given to its protection from vandalism, tramping and fire, by patrol and by guard rails along parts of its paths and trails. It has become necessary, owing to the increasing number of visitors, to increase the patrol and to place additional guard rails along more of the paths and trails; provision for part of this increased protection has been made in the budget for 1923; more may be required to ensure the safety of the grove.

A new investigation of this remarkable forest, including studies of its soils, its undergrowth, its reproduction, the number of trees, both large and small, and other features. has been referred by the Scientific Directors to a Committee consisting of Mr. Barrington Moore, Professor Richards and Dr. Gleason.

The natural reproduction of the hemlocks from their own seed, while continuous in parts of the grove, is local, the young trees coming up in colonies, and it may become desirable to distribute them or to plant additional young trees, raised from seed, in certain areas where the light conditions will allow their growth and development; this consideration will be given special attention by the Committee. The project for this investigation was drawn up by Mr. Moore.

Buildings

No new structures have been built during the year; the older ones have required and received many repairs and this work must be continued. The exteriors of the Central Display Greenhouse at Conservatory Range 2 and those of several houses at Range 1 were painted; the wooden bridge in the aquatic house, Range 1, was replaced by a concrete bridge; in continuation of the work of replacing iron-framed greenhouse benches by concrete ones, those in house 7, Range 1, were rebuilt. The roofs of houses 4 and 13 of Range 1 still require reglazing; application for a city appropriation of $15,000 for this purpose made at our request by the Commissioner of Parks has not yet been granted and the request has been renewed. A request for a city appropriation of $12,000 for a needed additional propagating greenhouse was referred back.

Our application for $25,000 city appropriation for the construction of two needed public comfort stations has not yet been acted upon.

The roof of the Lorillard Mansion requires repairs which we may be able to secure through the meagre City Budget appropriation for repairs and renewals. The room on the main floor of the Mansion prepared for exhibition purposes in cooperation with the Wild Flower Preservation Society of America has been equipped with framed paintings and with floor cases.

Details of repairs and renewals are recorded in the report of the Superintendent of Buildings and Grounds, hereto appended.

Paths and Roads

The parts of the path-system under construction in the southern part of the reservation have already been referred to in this report; these measure about 1,550 lineal feet, and it is planned to complete them during the coming season and to accomplish some work in connecting them with parts

of the system already constructed farther north. In the north meadows a connecting path about 450 feet long, partly constructed several years ago, was completed. The length of paths in our general plan, as yet unbuilt, aggregates a little more than two miles. The built paths and trails already in use aggregate over 16 miles in length; when the system is completed as planned, it will thus be about 19 miles long in all. As the use of the reservation increases, it appears desirable to add some connecting paths to our present plan.

Much resurfacing of paths previously built was necessary, largely due to a succession of violent summer storms. Ashes from the power houses were used for this purpose; they have the merit of not costing anything, but they are not as satisfactory as trap-rock screenings, used previously, now highly expensive. Several miles of additional guard-rails along paths will ultimately be needed.

The driveways have been maintained as in former years by the Park Department, under the provisions of the Charter, and we are grateful to Park Commissioner Joseph P. Hennessy for cooperation in this matter and in many other phases of our work. A city appropriation enabled him to have the traffic road rebuilt, and another city appropriation as yet unexpended is expected to complete the unfinished driveway running northeastward from the Rose Garden. The opening of the driveway in the Bronx River Parkway leading north from the Garden has greatly increased the use of the Garden driveways.

Reports Appended

I append reports made to me by Dr. Gleason, Assistant Director; by Dr. Small, Head Curator; by Dr. Murrill, Supervisor of Public Instruction; by Mr. Boynton, Head Gardener; by Dr. Stout, Director of the Laboratories; by Mr. Corbett, Superintendent of Buildings and Grounds; by Dr. Barnhart, Bibliographer; by Miss Harlow, Librari-

an; by Dr. Hollick, Paleobotanist; by Mrs. Britton, Honorary Curator of Mosses; by Dr. Rusby, Honorary Curator of the Economic Collection; by Dr. Denslow, Honorary Custodian of the Local Herbarium; and a schedule of expenditures by Mr. Groesbeck, Bookkeeper.

Respectfully submitted,

N. L. BRITTON,

Secretary and Director-in-Chief.

REPORT OF THE ASSISTANT DIRECTOR

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit herewith my annual report for the year 1922.

There has been no change in my official duties during the year, and a considerable portion of my time has been devoted, as before, to the ordinary routine of administrative detail.

It is a pleasure to record a considerable improvement in punctuality in the publication of the *Journal*, as well as a slight reduction in the cost. Mr. R. S. Williams has continued as editor, but the bulk of the editorial work has been assigned to Mr. James A. Crawford, associate curator. Volume 23, for 1922, contains 203 pages and 15 full-page plates.

Following the death of Mr. Geo. V. Nash, I was appointed an editor of *Addisonia* with Dr. J. H. Barnhart, and in that capacity I have given considerable attention to our relations with the printers and engravers who produce it. A new contract was made with the Art Color Photo Engraving Company for the last two issues of the current year, upon terms more favorable to us than any we have been able to obtain for some time past. Several other companies have submitted bids for the same work, all of which have been conspicuously in excess of the price we are now paying. It seems probable, therefore, that the financial position of Addisonia in this respect can not be

soon or greatly improved. While the first two numbers of the year were delayed far beyond their stated date, the October number appeared early in December and the December number was issued December 30. I believe we may expect little or no delay in the appearance of future numbers.

Mycologia has appeared as usual throughout the year.

Bulletin 42, the annual report for 1921, was published July 6, including 101 pages and opening volume 12.

During the year 3 numbers of the *Contributions* have been published, aggregating 52 pages, as follows:

235. Phytogeographical notes on the Rocky Mountain region. X. Grasslands and other open formations of the montane zone of the southern Rockies, by Dr. P. A. Rydberg.

236. Studies of West Indian plants. X., by Dr. N. L. Britton.

237. Cyclic manifestations of sterility in *Brassica pekinensis* and *B. chinensis*, by Dr. A. B. Stout.

My personal research has been devoted largely to the study of recent collections from British Guiana, involving naturally some examination also of material from adjacent countries. One paper has been transmitted for publication as a result. Some of the material has been referred to Mr. N. E. Brown for comparison with the collections at the Royal Botanic Garden, Kew, England, and from his preliminary reports it is apparent that British Guiana contains a wealth of undescribed species of flowering plants. I have also transmitted for publication two other major articles, on evolution and distribution in the North American species of *Vernonia* and on the genus *Vernonia* in Bolivia, besides several short notes and reviews.

My native collector, J. S. De La Cruz, has sent in large collections of British Guiana material, as a result of which over 1500 sheets have been or will soon be added to our collections. A large part of these come from the upper

Rupununi and Mazaruni rivers, territory hitherto unrepresented in our collections, and include materia' of great taxonomic importance.

Throughout the year I have served as a member of the Board of Control of Botanical Abstracts, on the board of directors of the American Iris Society, and on the board of directors and the exhibition committee of the Horticultural Society of New York.

Respectfully submitted,

H. A. GLEASON,
Assistant Director.

REPORT OF THE HEAD CURATOR OF THE MUSEUMS AND HERBARIUM

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to su'mit herewith my report as Head Curator of the Museums and Herbarium for the year 1922.

The collections under my supervision, public exhibits and research material, were cared for and developed by the methods in force during the past decade.

A total of 62,608 specimens were added to the general collections. They were received through the several channels which may be tabulated as follows from the Museum and Herbarium accession lists which were printed in several numbers of the Journal:

By gift and purchase	48,052
By exchanges	7,264
By exploration	7,219

The value of the specimens received as gifts amounts to $4,637.10.

More than five thousand duplicate specimens were sent to other institutions and to individuals in exchange for other specimens.

Museums

The museum equipment was increased by a case for exhibiting the flowers and fruits of species described in

the recently issued volume two of the Cactaceae and by numerous museum jars for the display of specimens.

The Economic Museum

The greater part of the addition to this museum represents the materials collected by Dr. H. H. Rusby and his associates on the Mulford Biological Exploration of the Amazon Valley. All the specimens hitherto installed were furnished with numbers corresponding with those in the "Guide to the Economic Museum." The labeling of the more recently installed specimens has been continued.

The Systematic Museum

Of the four divisions of this museum, the *Synoptic Collection* was increased by miscellaneous specimens, mainly derived from collections gathered in the course of exploration by members of the garden staff; the *Local Flora* remained the same as in the preceding year, except for the addition of a few specimens in the lower groups of plants; the *Microscope Exhibit* was maintained as heretofore, with the renewal of several specimens; the *Plant Picture Exhibit* remained the same as it was last year.

The Fossil Plant Museum

Valuable specimens from different geologic horizons, from the northern regions of the Old World and the New, as well as from some of the western States were added to the resources of the fossil plant collections. For details see the report of the Paleobotanist.

Herbarium

No new equipment was added during the year. The capacity of the present equipment was taxed to near the limit.

More than 52,256 specimens were received. They represent a wide geographic range. Some came from the

Philippine Islands, China, Europe, and Africa; but the great bulk was received mostly through the purchase of the Collins herbarium and as a result of exploration under your direction in Tropical America. Cuba, Porto Rico, Mexico, Central America, Panama, Colombia, Venezuela, British Guiana, Bolivia, and Brazil contributed the material upon which activities are now centered.

Drafts upon the collections received during the year and from the accumulations of previous years not yet drawn upon, amounting to about 18,000 flat specimens, were incorporated in the permanent collections, mounted on about 14,000 herbarium sheets, and several hundred bulky specimens were stored in cardboard boxes. A rather unusual accession to the herbarium was a large series of photographic prints of type specimens of succulents, of old paintings of plants cultivated and flowered at the Royal Botanic Gardens, Kew, in the earlier part of the nineteenth century, and of living plants, mostly in flower, of *Mesembryanthemum*.

Considerable attention was given to the conservation of the collections already mounted, which were used extensively in studies by members of the scientific staff and other qualified investigators approved by you. Some of the activities additional to routine and mechanical curatorial work are referred to below.

Investigations and Assistance

Dr. P. A. Rydberg, Curator, continued in charge of the phanerogamic herbarium. During the first four months he was occupied mainly with mechanical work, principally in connection with the unmounted material. During the summer months some time was spent in preparing an appendix to his *Flora of the Rocky Mountains*, of which the second edition will be issued this winter. The remainder of the time was taken up by routine work, and in distributing about 5,000 mounted specimens into the

herbarium cases. During the fall some time was given to taxonomic work, mostly in preliminary studies in the family Fabaceae, and to reading proofs on one part of North American Flora which will be issued at an early date. One paper, Phytogeographic Notes on the Rocky Mountain Region, X., was published last February.

Dr. Marshall A. Howe, Curator, continued to have special charge of the collections of algae and hepaticae. Good progress has been made in entering in the herbarium the Collins collection of algae purchased early in the year by yourself, and generously donated by you to the Garden. This collection includes somewhat more than 40,000 specimens and was one of the largest existing private collections of this group of plants. Dr. Howe, also, for the fifth season, gave special attention to the exhibition border of dahlias. He acted as judge at several of the leading dahlia shows in the East, wrote the text for a recently published dahlia number of *Addisonia*, and contributed articles on the dahlia to *The Garden Magazine* and to the *Bulletin of the American Dahlia Society*. Another important paper published by him during the year is "Two New Lithothamnieae from the Lower Miocene of Trinidad, British West Indies," in the *Proceedings of the U. S. National Museum*. He continued to act as secretary of the Torrey Botanical Club and associate editor of its publications, as a member of the Council of the New York Academy of Sciences, and as a member of the Board of Control of *Botanical Abstracts*. He has given four lectures in the Saturday afternoon courses, one in the weekly convocation series of the Connecticut College for Women at New London, and several others in the vicinity of New York City.

Dr. Fred J. Seaver, Curator, continued in charge of the collections of ascomycetes and lower fungi, Dr. Murrill having cared for the higher forms. Some time and attention was devoted to a study of the tropical fungi with especial reference to Porto Rico. Manuscripts on the fungi of Porto Rico and the Virgin Islands are being

prepared by him in cooperation with Mr. Carlos E. Chardon of the Insular Experiment Station of Porto Rico for use in connection with the scientific survey which is being made of those islands by the New York Academy of Sciences. One part of *North American Flora* on the genus *Phyllosticta* was completed and published. Several smaller papers were also published, three lectures given in the regular Saturday afternoon course at the Garden and one in the winter lecture course. Regular routine of preparing and mounting specimens and in treating them to prevent their destruction by the brown-beetle and buffalo-moth was maintained. He has also given some attention to insects and fungi affecting living plants.

Mr. Percy Wilson, Associate Curator, has carried on his studies throughout the year on tropical American plants. The Flora of Porto Rico and the Virgin Islands, which he has been working on in cooperation with yourself, has progressed rapidly and it is expected that a part will be issued soon. He devoted considerable time to the naming of specimens received from various institutions, and also for members of the Garden staff. His docentry work was greatly increased owing to the growing number of requests from visitors who have applied for special instruction, as well as classes for both public and private schools.

Mr. James A. Crawford, Associate Curator, has been preparing an index to the taxonomic literature of botany contained in the periodicals of the library, assisting Dr. Gleason with his specimens of British Guiana plants, assisting in editorial work on the Garden Journal, taking special photographs within the Garden, and occasionally guiding classes of students from local schools and colleges about the plantations and conservatories.

Dr. H. H. Rusby, Honorary Curator of the Economic Collections, continued to develop the exhibits of the Economic Museum. See his report.

Mrs. N. L. Britton, Honorary Curator of Mosses, continued with the assistance of Mr. R. S. Williams,

Administrative Assistant, to develop the Moss Herbarium. See her report.

Dr. Arthur Hollick, Paleobotanist, continued in charge of the fossil plant collections. See his report.

Dr. H. M. Denslow, Honorary Custodian, devoted his time at the Garden to the development of the local flora collection. See his report.

The writer, in addition to routine work, continued his general studies in the plants and plant-geography of the southeastern states and special studies in our native cycads, palms, spider-lilies, and flags. The latter part of April and the first part of May was devoted to further exploration in peninsular Florida and on the Florida Keys. At the same time further studies were made both in the field and in the Deering Reservations at Buena Vista and Cutler, among the cacti and other special groups of plants. The end of August and beginning of September were devoted to gathering living cacti of the eastern Coastal Plain for a public exhibit in conservatory range 2. The last two weeks of December were devoted to further exploration and collecting, and to special studies in peninsular Florida.

A number of articles, largely the results of the past and present field work, were written and some of them published in the *Journal* and in *Addisonia*.

Respectfully submitted,

JOHN K. SMALL,

Head Curato. of the Museums and Herbarium.

REPORT OF THE SUPERVISOR OF PUBLIC INSTRUCTION

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1922.

Lectures

The lecture courses were further extended during the year and instruction by correspondence, interviews, walks, etc., was given freely to all who applied.

Fifty-four illustrated public lectures on botanical and horticultural subjects were given in the museum building on Saturday and Sunday afternoons from April 15 to October 15 inclusive, the titles of which were published in the *Journal*. Members of the Garden staff gave 35 of the lectures and the remaining 19 were by outsiders. The attendance on Saturdays and Sundays averaged 67 for the 40 spring and summer lectures and 99 for the autumn lectures. The maximum attendance on Sunday was 148, at the lecture by Dr. Gleason on May 28, and the maximum attendance on Saturday was 215, at the lecture by Dr. Howe on September 23. The general average for all the public lectures in the museum building for the season was 76.

In March, April, October, and November two courses of four lectures each, as published in the *Journal*, were given in the central display greenhouse of conservatory range 2. All the speakers were from the Garden staff. The attendance reached a maximum of 70 on October 21, at the lecture by Dr. Rusby, and the general average for all the lectures was 31.

A new course of Sunday lectures in the central display greenhouse of conservatory range 2, to be continued throughout the winter, was inaugurated on December 3 with a lecture by Dr. Britton on "Forest Cacti."

Abstracts of many of the above lectures appeared in the *New York Times* and the *Bronx Home News*.

School Lectures and Demonstrations

Several classes in biology from various public high schools visited the Garden for the study of living plants and museum collections and for lectures in our lecture hall. These exercises were under the general direction of the school teachers, guided by myself and assisted by various members of the Garden staff.

Docentry

Many special appointments were made outside of the regular schedule. Parties of high school pupils and Girl Scouts were conducted by members of the staff through various parts of the grounds. Students and teachers from Columbia, Rutgers, Hunter College, Froebel Institute, and elsewhere also came in groups.

Meetings

Among the various meetings held at the Garden during the year, I may mention the joint session of the Torrey Botanical Club, Wild Flower Preservation Society of America, and New York Bird and Tree Club, at the mansion on April 26, which was attended by about one hundred people. An important meeting of the American Iris Society was also held at the mansion in May, in connection with the Iris exhibition.

Floral Exhibitions

The Horticultural Society of New York, in cooperation with the New York Botanical Garden, held exhibitions of flowers in the museum building on the dates given below. The collections of irises, peonies, roses, dahlias, etc., on the grounds also attracted large crowds of people.

May 13, 14. Exhibition of Flowers.

May 27, 28. Exhibition of Irises in cooperation with the American Iris Society.

August 18–20. Exhibition of Gladioli.

September 22–24. Exhibition of Dahlias.

Personal Investigations

Lectures, editorial work, correspondence, docentry, and other forms of public instruction have allowed very little opportunity for scientific work. My correspondence, both general and mycological, has been unusually heavy. Editorial work on *Mycologia* and *North American Flora* was

continued as usual. Five main articles, mostly on dark-spored agarics, and many shorter articles and notes on various mycological subjects were prepared and published in *Mycologia*. Considerable field-work was done at Yama Farms in the southern Catskills. Several new lectures were prepared for the various Garden courses, a list of which will be found in the *Journal* for 1922. Miss Helen A. Purdy has rendered valuable assistance in my department.

Respectfully submitted,
W. A. MURRILL,
Supervisor of Public Instruction.

REPORT OF THE HEAD GARDENER

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to present herewith my report for the year 1922.

Horticultural Operations

The planting and care of the plantations in grounds and greenhouses, under the supervision of Messrs. John Finley and H. W. Becker, foreman gardeners, was carried on with a force of 27 gardeners, 14 laborers, and 1 apprentice gardener. The usual operations of cultivation were pursued and considerable new planting made. Under Mr. Finley's direction evergreens and shrubs in conservatory beds were rearranged and 7 varieties put in the Pinetum collection as specimens; 33 trees were planted along the main drives, including 20 red oaks along the drive from the mallow collection to the iris garden entrance and three trees in the lilac garden; a permanent hedge of privet was set out around the stable yard; 32 trees, mostly oaks, phellodendron, and poplar, were planted along Pelham Avenue near the new entrance; 26 young trees were planted in the arboretum, 20 plants of *Salix gracilistyla*, our earliest willow, were planted along the drive west of the long bridge, and 12 Swiss stone pines were moved to the entrance

of the horticultural garden, where six were placed on each side. In the rose garden 14 new beds were made, 2,700 plants were planted, including 200 standards, and the old plants arranged in the outer beds. In the lilac garden 56 plants were moved and replanted and 154 new ones put in place. In the iris garden 4 new beds were made and 750 plants placed therein. Another new peony bed was made and 75 plants transferred to it from the conservatory beds. A new bed was prepared for the collection of perennial phlox and 223 plants placed. The lily collection was partially replanted and a new bed made to accommodate 30 additional kinds. A collection of 1,600 tulips, donated by John Scheepers, Inc., was planted in the old rose bed east of conservatory range 1 and 5,000 narcissi in the conservatory court beds and on the border of the canna bed. The mallow collection received 250 more plants. The rock garden, under the supervision of Dr. E. B. Southwick, was built up nearly to completion, 2,855 plants being placed and space left for additional planting in the spring. The fern garden has been augmented by 500 plants on rocks.

Under Mr. Becker's direction more palms were planted out and further rearrangement effected in house 1, conservatory range 1, Contingent upon the replacing of the bridge in the aquatic house, all the aquatics were taken out and replanted. In house 7 the cacti on the side benches were rearranged and 130 plants transferred from the propagating house. The climbing Cereus, Rhipsalis and Epiphyllums, 230 in number, were transferred to conservatory range 2, where the bromeliads were transferred to a portion of the orchid house and propagating house and the house left vacant used for the climbing cacti, Epiphyllums, and Dr. Small's collection of cacti of the Atlantic Coastal Plain. At conservatory range 2, 1,800 plants, including 500 chrysanthemums, 200 cinerarias, 250 begonias, and cyclamen, primula, carnation, and stock, were raised for exhibition in the central display house. At the

propagating houses many new seedlings were propagated for the woody collection, annuals for the conservatory beds, etc.

Systematic Plantations

Herbaceous Grounds. The herbaceous collections comprise about 3,500 species and varieties in herbaceous grounds, nurseries, and flower gardens.

Woody Collections. In the fruticetum, salicetum, arboretum, and viticetum are located about 3,000 plants, representing 800 species and varieties in 90 genera.

Conservatories. Nearly 23,500 plants are now housed under glass, representing 9,000 species and varieties disposed as follows: range 1, 8,465; range 2, 10,686; propagating house, 4,295. In the conservatory court lily tanks 54 varieties of water-lilies were shown this year.

Miscellaneous Collections

Rose Garden. The collection now contains 3,800 rose plants, including the best of those which flowered during the present season, augmented by Messrs. Bobbink and Atkins' planting of 2,700. Beds are ready for 500 additional plants which they will send in the spring.

Dahlia Garden. Under the direction of Dr. Marshall A. Howe, the dahlia border contained 833 plants of 475 varieties, obtained from roots grown previously and from new varieties given by some 25 dahlia enthusiasts.

Gladiolus Collection. This collection was increased by five varieties from Mr. J. A. Kemp, Little Silver, N. J., and small lots from other donors, making with the Kunderd and Childs collections 220 varieties and 15,000 bulbs.

Canna Collection. The display of cannas, which were the best in quality we have had in several years, contained 1,300 plants of 70 varieties.

Iris Garden. Through the continued cooperation of the American Iris Society, the number of iris plants reached

2,975 and the varietal names number 1,023. The chief additions were plants imported by the Society from French and English growers.

Lily Garden. The lily beds were planted with 400 additional bulbs made available through the cooperation of Mrs. Mortimer J. Fox and Mr. T. A. Havemeyer. There are now 43 varieties represented.

Variegated Plant Collection. This group contained 600 plants of 57 species and varieties.

Tulip Collection. The tulip display of 19,000 bulbs in the conservatory courts and horticultural garden bloomed last spring. This fall a collection of 53 varieties of Darwin, Cottage, and Breeder tulips, given by John Scheepers, Inc., was planted in the old rose bed, east of conservatory range 1.

Phlox Collection. Our new phlox collection consists of 223 plants representing 25 varieties of perennial phlox of the *paniculata* and *suffruticosa* groups.

Narcissus Collection. This display now amounts to about 6,000 plants. In addition to the planting of King Alfred at the horticultural garden, we have 5,000 plants of 5 other large trumpet types of daffodils planted in the conservatory court beds and canna beds for next spring's display.

Peony Collection. The 3 peony beds now contain 265 plants of 88 varieties, of which 75 plants of 38 varieties were added from our old collection.

Mallow Collection. This contains 790 large plants, including the Meehan and Bobbink and Atkins groups and those from Dr. Stout's collection, 250 of which were added this year to fill the area.

Fern Garden. Under the supervision of Dr. E. B. Southwick, the fern garden has grown to 8,500 plants, 500 of which he collected this year for the higher rocky portion of the site.

Rock Garden. The planting in the rock garden has been nearly doubled this year. Under Dr. Southwick's

guidance 2,855 plants were added, some collected by Dr. Southwick; a splendid collection of 200 varieties was given by Mr. Clarence Lown of Poughkeepsie, N. Y., and 45 varieties by the Brooklyn Botanic Garden. An estimate places the number of plants here at 5,355.

Lilac Garden. Through the cooperation of Mr. T. A. Havemeyer, 154 plants of 72 varieties were added to the lilac groups, giving a total of 412 plants of 150 varieties.

Labeling, Recording and Herbarium

The work has been in charge of Mr. John Hartling, Head Gardener's Assistant, with 1 label boy for the whole year and 1 other label boy for 4 months. A total of 4,049 labels have been placed, 75 signs have been made and relettered, and about 3,500 have been made and repainted ready for lettering.

Accession numbers 50,442 to 51,366 have been recorded making a total of 925 accessions for the year. The number of packets of seeds received was 783; by gift 22, by purchase 279, by exchange 476, by collection 6. The total number of plants received was 9,116; by gift 3,047, by exchange 432, by purchase 5,369, by collection 261, from seed and other sources 2. The herbarium of cultivated plants has been increased by 250 specimens. Many specimens and materials have been collected for use at Columbia and like institutions.

Investigations and Lectures

I have given four lectures in the regular courses and three in the greenhouse and winter courses, and have demonstrated our collections of shrubs and evergreens to students of horticulture from Columbia University.

Respectfully submitted,

KENNETH R. BOYNTON,

Head Gardener.

REPORT OF THE DIRECTOR OF THE LABORATORIES

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1922.

During the last three and one half months of the calendar year I have, with permission of the Board of Managers, been on leave of absence from the Garden and it is planned that this absence will extend until June 15, 1923. During this time Miss Hester M. Rusk is continuing the most important of the various lines of research which have been in progress and performing the routine duties involved in the care of the laboratories and the taking of meteorological records. Mrs. Jean Kerr has throughout the year rendered valuable aid as a voluntary and unpaid assistant in the prosecution of several of the experimental studies.

A period of one week during June was spent at the New York State Experiment Station at Geneva in continuing the studies of grapes, of which an account has already been submitted.* Special effort was made to obtain crosses between tender seedless varieties and hardy near-seedless plants. At the present time several thousand seedlings from seed of controlled pollinations of the previous year are being grown at the Station.

During the summer, I spent two weeks at Presque Isle, Maine, prosecuting studies of sterility and fertility in varieties of the Irish potato. This was the second year of cooperation with the Bureau of Plant Industry in this research. An investigation of over 100 varieties has now been made and a report of the results is in manuscript ready for publication.

At our own experimental plots and greenhouse considerable investigation has, as in previous years, been directed to studies of sterility and fertility. The phenomena of intersexualism have been studied particularly in *Plantago lanceolata*, *Cleome spinosa*, *Lythrum Salicaria*, and in

* Journ. N. Y. Bot. Gard. 22: 148–156. 1921.

certain varieties of *Pelargonium*. *Cleome spinosa* has exhibited repeated cyclic changes in sex with decided intermittency in the production of fruit. Incompatibilities in fertilization have been studied in several species, but especially in species of *Hemerocallis* and *Brassica*. *Brassica pekinensis* has given results of unusual interest and results which may have an important bearing on crop production.

From the first year of my association as a member of the staff of the New York Botanical Garden, the phenomenon of bud variation has been under investigation. My interest has extended to all of the problems involved in vegetative propagation such as the occurrence and nature of bud variation, the transmission both through seed and through bud progeny of the different types of bud variations and the somatic and biogenetic organization of plants long propagated by vegetative means. *Coleus*, *Pelargonium*, and *Abutilon* have been favorable material for these studies.

At the present time, investigations with species of *Lilium* comprise a major effort in which Mrs. Mortimer J. Fox, Miss Rusk, and I are cooperating. A report of the aims of these studies has recently been submitted to you.* Progress in these studies has been very satisfactory. We have cooperated in preparing a number of Addisonia devoted entirely to lilies.

A word may perhaps be added regarding my research during the stay in southern California. I am finding here opportunity to continue my studies of sterility and fertility and to extend such studies to several important fruit crops and such researches are occupying the greater portion of my time.

The list of students formally registered during the year for research at the Garden is as follows:

Glover, Clifford C., Taxonomy of the Caprifoliaceae.
Hylander, Clarence J., Algae, the Cladophoraceae.
Johnson, Alice M., Sterility in *Piaropus*.
Kozlowska, Aniela, Paleobotany.
Lanfear, Mrs. L. H., Genetics, Cytology.

* Journ. N. Y. Bot. Gard. **23**: 155–158. 1922.

Dr. Mel. T. Cook spent several months at the Garden at the end of the year in research in pathology and morphology.

Respectfully submitted,
A. B. STOUT,
Director of the Laboratories.

REPORT OF THE SUPERINTENDENT OF BUILDINGS AND GROUNDS

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1922.

Regulating and Grading.

Considerable work was accomplished along Pelham Avenue, west of the Bronx River, where about an acre and a half of ground was regulated, graded, and made ready for planting, and on the eastern side of the river, near the Mansion Approach Entrance an acre of ground was also graded and made ready for planting. The quarry near conservatory range 2 was filled in and graded for a depth of four feet, and a quarter of an acre of land here is ready for planting.

Outside contractors working in the vicinity of the Garden, looking for a convenient place to dispose of soil from excavations, carted about 1,200 cubic yards into the Garden at their own expense. This included about 300 yards of top soil, which we used for the rock garden and as a top dressing for the flower beds in the herbaceous grounds and near conservatory range 2. In order to fill in the new road near the large lake, 600 yards of this soil were utilized and about 200 yards for filling in along Pelham Avenue west of the Bronx River; the remaining 100 yards were put along the boundary of the Garden just north of the Woodlawn Road entrance.

Nearly 175 cubic yards of stone were blasted and removed from the quarry north of the museum building.

This stone was used for the construction of paths at the southern end of the Garden and for those in the north meadows. About 75 yards of stone were blasted and taken from the quarry near conservatory range 2 for the construction of the foundation and rubble-stone work of the new fence along Pelham Avenue, and also for the lining of paths.

Drainage

In order to drain the ground graded near Pelham Avenue west of the Bronx River, two catch-basins were installed and 378 feet of 6-inch tile pipe were utilized.

Water Supply

Necessary repairs were made to the main water-supply pipes in front of the museum building. Other important repairs were made to the water systems in the basement of the museum building, in conservatory range 1, in all the comfort stations and at the drinking fountains.

Paths

Near the southern end of the Garden west of the Bronx river, a 10-foot path 573 feet long was lined and three-quarters of it was paved. Another path 993 feet long was built through the lilac garden near the mansion, of which three-quarters was also paved. In the north meadows a 10-foot path 441 feet long was paved, covered with ashes and rolled down. For the purpose of paving the paths about the lilac garden, 150 cart-loads of stone were removed from the arboretum grounds near the shelter house. A 10-foot road 490 feet long, running along the railroad boundary from power house 1 to the Elevated Railway Approach, was lined and made ready for paving. The path from the 200th Street entrance to the Elevated Railway Approach was raised 8 inches for a distance of 465 feet, filled in with trap-rock, which had been taken from the traffic road while this was being rebuilt by the Park

Department, rolled and finished, and the road leading to power house 1 was raised 8 inches, rolled and finished. The path leading to the Elevated Railway Approach, between the traffic and pleasure roads, which is 60 feet long and 20 feet wide, was raised 6 inches, rolled and resurfaced. The path from the Southern Boulevard entrance to the Elevated Railway station was raised 8 inches for a distance of 300 feet, resurfaced and rolled. All the paths on the terrace around conservatory range 1 were resurfaced and rolled, and the paths through the iris garden were resurfaced with ashes and rolled.

Buildings

The halls, walls of the upper floor and north wall of the mezzanine floor of the museum building received two coats of paint. The carpenter made the necessary repairs to the doors and windows and the plumber and the steam engineers repaired the steam and water systems in the museum building.

The upper dome of house 1 and the exterior of houses 5 and 11 of conservatory range 1 were painted. Repairs were made to the sash bars in houses 4, 5, 11, and 13 by the carpenter and painter. Ten steam coils in house 1 and one line of steam-pipe on the center bench in house 6 were replaced. All needed repairs were made to the steam system in conservatory range 1 by our steam engineers. The plumber repaired the water leaders and drain-pipes, and the carpenter made all necessary repairs to the doors and sash. On account of the cyclonic storm of January 11, an unusually large amount of glass was broken in conservatory ranges 1 and 2; the damage was covered by insurance policies. In order to replace the broken glass at conservatory range 1, six and a half boxes of glass 16 x 24 inches were used and at conservatory range 2, four boxes of glass 30 x 48 inches. All other glass broken during the year was replaced. The rustic bridge in the aquatic house was replaced by one of concrete. A concrete bench,

three tiers high, was built in the center of house 7, conservatory range 1.

The exterior of the central display house of conservatory range 2 received two coats of paint. The rafters were repaired, as were the steam, water and drainage systems. All broken glass was replaced. New gutters and leaders were installed at the propagating houses and stable.

Two exhibition cases to be used for the exhibition of publications were built for the first floor of the mansion. The front exhibition room on the first floor was painted and all necessary repairs were made to the windows and doors by the carpenters.

The brickwork of the boilers at power houses 1 and 2 and the steam systems were repaired.

A foundation 130 feet long, 12 inches wide, and 3 feet deep was built under the Elevated Railway Approach for a proposed storehouse and shop. A brick wall 8 inches wide and 14 feet 4 inches high was placed over this foundation and six windows were installed.

Grounds

The cedar fences along the Bronx River and at the Woodlawn Road approach were repaired by the carpenter. The chestnut bridge in the north meadows was refloored and a new railing constructed. Nearly 350 feet of one-rail iron fence was erected near the iris garden and repairs were made to the railings throughout the grounds. The new fences along the Southern Boulevard and at Pelham Avenue near the mansion entrance received two coats of paint, as did the one- and two-rail fences through the hemlock grove. An 8-foot, stone and iron, boundary fence along Pelham Avenue east of the Mansion Approach entrance, mentioned in last year's report, was extended for a distance of 380 feet. To erect the boundary fence on the west side of the Bronx River on Pelham Avenue, 385 feet of foundation, 360 feet of 18-inch rubblestone, two gate piers and five 20-inch piers were constructed.

The Department of Parks rebuilt the traffic road from 200th Street to the Southern Boulevard entrance with concrete and asphalt.

Twelve new rustic benches were built by the carpenter. A map of the Garden was placed at each entrance. All signs throughout the grounds were repaired. A sufficient quantity of wood was cut from dead or fallen trees to supply the propagating houses with fuel for four and a half months and the mansion for one month. The uprooting of the poison ivy has been continued.

Parties, averaging about ten a week and consisting of from 75 to 2,000 children, visited the Garden from May until September. These children were from the public and Sunday schools of Greater New York, as well as from New Jersey. They were escorted to the three picnic grounds set aside for this purpose, and special guards were detailed to these grounds every day.

From May until November for five days a week, including Saturdays and Sundays, two city officers in civilian clothes were stationed in the Garden. Twelve additional guards selected from the laborers and gardeners in addition to our own keepers have helped also to protect the grounds. At all times during the year a city officer has been assigned to the Garden. Over 200 summonses were given by the officers of the Police Department for violations of park ordinances, the offenders being fined from one to ten dollars each by city magistrates. On Saturdays, Sundays and holidays during the summer months, the average number of visitors numbered about 50,000; in July and August this number was greatly augmented. The plantations suffered little from vandalism because of the watchfulness of our employees.

On account of the ever-increasing number of visitors to the dahlia, gladioli and rose collections, a special guard was detailed to watch these collections day and night.

Respectfully submitted,

ARTHUR S. CORBETT,

Superintendent of Buildings and Grounds.

REPORT OF THE BIBLIOGRAPHER

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1922.

Assistance to visitors and members of the staff in their use of the library, and work in botanical bibliography, have as usual consumed considerable time; but the bibliographer has given particular attention to his editorial work. Conditions in the printing trade have shown marked improvement, especially during the second half of the year.

Four numbers of *North American Flora* have appeared during the year. Volume 6, part 1 was issued in April, volume 33, part 1, in September, and volume 7, part 7 and 8 in December. Even this record has been attained only by the use of two printing establishments at the same time. Two numbers are in press. More than four thousand pages of *North American Flora* have now appeared; one volume is complete, and sixteen are in course of publication.

Of *Addisonia*, five numbers have been issued: the final number of the sixth volume, and all of the seventh. Two hundred and fifty-six plates have now been published in color in this journal.

The growth of the library is recorded in the report of the Librarian. There have been few particularly important accessions; perhaps the most noteworthy single volume is Ventenat's *Choix des plantes* (1803), a folio volume with 60 plates.

In recent years the development of the photostatic method for the reproduction in fac-simile (either negative or positive) of rare books and papers has opened a new field in library development, and it is now possible in many cases to secure good working copies of publications not otherwise available. Our library has several such photostatic copies; all of these have been presented by friends interested in the particular cases involved. The bibliographer has had several such copies made for the library at his own expense during the past year. It is perhaps too

soon to suggest that the Garden should install photostatic apparatus for the copying of its own rarities, but some special provision should certainly be made for securing needed copies of the botanical treasures of libraries where such apparatus is already installed.

The bibliographer has published but little of his own during the year; chiefly scattered biographical notes in the Garden *Journal*, and a paper on nomenclature in the September number of the *Journal of Botany, British and foreign*. The period covered by the present report marks the completion of twenty years of service on the scientific staff of the New York Botanical Garden.

Respectfully submitted,

JOHN HENDLEY BARNHART,
Bibliographer.

REPORT OF THE LIBRARIAN

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1922.

A recent census of the library shows a total of 31,038 bound volumes, a gain of 504 over the census of 1921. Of these there were acquired by purchase 126, by exchange and deposit 20, and by gift 23. The principal accessions have been listed as heretofore in the *Journal*. During the year 40 volumes have been permanently recalled by Columbia University. This number included their set of the *Berichte der deutschen botanischen Gesellschaft* which has now been replaced.

There have been bound 374 books belonging to the Garden and 57 belonging to Columbia. It was decided that library buckram should in most cases be substituted for morocco as a binding material, having the advantage of greater economy as well as durability.

The new catalogue case, installed at the entrance to the stack room in March, has greatly relieved the crowded condition which formerly prevailed. There have been

added to the catalogue 1,330 type-written cards, 3,519 of the printed ones issued by the Torrey Botanical Club, and a large number of guide cards.

Additional space for shelving folios is needed that such volumes may be kept in their proper sequence and protected from injury due to over-crowding.

Lack of full time assistance has rendered it difficult to attend to all the varied details which are involved in the administration of a library of this size, but it is trusted that the present report may be found to compare favorably with those of former years.

Respectfully submitted,

SARAH H. HARLOW, *Librarian.*

The following additions and corrections should be made to the list of serials which was appended to the report of the Librarian for 1921 (*Bulletin* 12: 41–61).

Omit the following:

Park International.

Omit § before the following:

Bremen. Naturwissenschaftlicher Verein, Bremen, Germany. *Abhandlungen.*

Sociedad de Ciencias Naturales del Instituto de la Salle, Bogota Colombia. *Boletin.*

Change the following:

California State Commission of Agriculture to California State Department of Agriculture.

Massachusetts Horticultural Society, *Transactions* to *Annual Report*, *Bulletin.*

Add the following:

British Guiana. Department of Science and Agriculture, Georgetown, British Guiana. *Journal*, *Report.*

Deutscher naturwissenschaftlich-medicinischer Verein für Böhmen: "Lotos," Prag, Czecho-slovakia. "Lotos."

Milwaukee. Public Museum. Milwaukee, Wis. *Bulletin*, *Report*, *Year Book.*

Naturwissenschaftlicher Verein für Steiermark, Graz, Austria. *Mitteilungen.*

Ohara Institut für landwirtschaftlich Forschungen, Kurashiki, Japan. *Berichte.*

‡ Petrograd. Jardin Principal Botanique, Petrograd, Russia. *Bulletin*, *Notulae systematicae ex Herbario*, *Notulae systematicae ex Instituto Cryptogamico.*

REPORT OF THE HONORARY CURATOR OF THE ECONOMIC COLLECTIONS

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to submit the following report on our economic collections for the year 1922, during which period several important improvements have been made in the Museum.

Since the printing of our Catalogue, many specimens have been added, for the satisfactory and permanent recording of which provision has now been made. A suitable binder, with a sufficient number of large blank sheets, has been prepared and upon these sheets the pages of the catalogue have been mounted so as to leave wide margins for annotations. On these pages have been recorded all museum additions to date. Besides providing a current record, these sheets will serve as printer's manuscript when a new edition of the catalogue is desired. In connection with the above work, the entire collection has been supplied with numbers printed in large and heavy type, so that reference to the catalogue is facilitated. The only desideratum now remaining to render our collections fully serviceable is suitable labeling of the specimens, a work which we hope to complete during the coming year.

The additions to our collections are numerous and of peculiar interest. As Director of the Mulford Biological Exploration of the Amazon Valley, I devoted myself assiduously during the latter half of 1921 and the early part of 1922, to the collection of the economic vegetable products of the region traversed from La Paz, Bolivia, through the valleys of the Quime, Canamina, Meguilla, La Paz, Bopi, Beni and Madeira Rivers and upon the lower portions of the Cochabamba and Negro. In this work, I was ably assisted by Dr. O. E. White, of the Brooklyn Botanic Garden. Separately or together we made a number of side trips into various adjacent regions. Although many cultivated products were obtained, by far the greater number represent native plants. The

most important group consists of food products, especially edible fruits. It is probable that very few of these are represented by characteristic specimens in any other collection. The method of collection and preservation was that usually employed by us. A large number of two-quart glass fruit jars, with an ample supply of formaldehyde, were carried, so that we were enabled to preserve the form, and to a great extent the color of the specimens collected. Owing to the crude methods of transportation, many of the jars became broken, but anticipating this result, such methods of packing were employed that there was little destruction of the specimens contained in the broken jars. The expense of transporting this equipment was very heavy and science is greatly indebted to the H. K. Mulford Company for providing the necessary means. We also received material assistance from the Bolivian representatives of the Messrs. Guggenheim Brothers. My personal indebtedness on this score is very great, as it is probable that I could not otherwise have survived the exposure and hardship to which I was subjected.

Not only are the specimens collected on this expedition unique in collections, but they are botanically little known and some evidently quite unknown. All of my available time for many weeks will be required for their determination.

Record is here made of the receipt of another consignment of specimens of proximate principles from Messrs. Merck & Company, replacing those which they removed for improvement or replacement. It is hoped that the entire remainder of this collection may be received during the coming year.

In conclusion, I can report the conditions for the collection of local materials during the coming year as being exceptionally favorable.

Respectfully submitted,

H. H. RUSBY,

Honorary Curator of the Economic Collections.

REPORT OF THE HONORARY CURATOR OF MOSSES

DR. N. L. BRITTON, Director-in-Chief.

Sir: The accessions for the year 1922 number 430, and 870 duplicates have been distributed as exchanges. These accessions have been acquired through purchase, collection, and exchange, and represent a wide range of localities in North and South America, as well as the Old World. All have been or will be recorded in the *Journal*. Duplicates have been distributed from Porto Rico, British Guiana, Cuba, and Trinidad. Mr. R. S. Williams has taken charge of the collections during my absence and given much time to study of Tropical American species, particularly South American.

The collection of lantern slides has been increased by 146 colored and 113 uncolored slides and 160 negatives have been added.

Acting as Secretary for the Stokes' Fund and the Wild Flower Preservation Society I have answered letters, distributed literature, and given several lectures to garden Clubs in the vicinity of New York.

Respectfully submitted,

ELIZABETH G. BRITTON,

Honorary Curator of Mosses.

REPORT OF THE PALEOBOTANIST

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to report as follows upon paleobotanical activities during the year 1922.

During the period from February 15 to September 30, I was in Washington, D. C., on leave of absence, engaged upon work on the fossil flora of Alaska for the United States Geological Survey.

From January 1 to February 14 and from October 1 to December 31 my time and attention were especially given to the study of certain of the paleobotanical collections of the Garden and in general to the development

of the paleobotanical museum and library. The principal items of study were concerned with the fossil flora of Brazil (in cooperation with Prof. E. W. Berry of Johns Hopkins University); the fossil flora of the West Indies; and certain specimens representing genera whose identity has been the subject of frequent discussion. Photographs or drawings were made, and descriptions and discussions were written for inclusion in papers in course of preparation on these several items. In this connection the cordial cooperation and assistance of the U. S. Geological Survey is here acknowledged, especially for expert photographic work.

Sixty-six specimens, including thirty-eight species, were added to the paleobotanical collections, all but two of which were obtained through exchange of material. The most important single accession consists of 48 specimens of Triassic and Jurassic plants from Scandinavia, received from Prof. Rudolf Florin of the State Museum at Stockholm, Sweden. These specimens include twenty-seven species, nearly all of which were not previously represented in the Museum collections.

Thirty-one paleobotanical publications were received, from seventeen different authors, five of whom contributed their works for the first time. Our paleobotanical mailing list now includes some fifty names of active workers, with about twenty-five of whom correspondence was exchanged.

Three articles, personally written, dealing directly or indirectly with fossil plants, and based upon Garden material, were issued during the year. I also prepared and presented three communications on paleobotanical subjects at meetings of scientific societies.

Among those who visited the Museum in order to obtain paleobotanical information, or to study certain of the fossil plant collections, were Professor Ralph W. Chaney of the Carnegie Institution of Washington, who is engaged in an investigation of the Tertiary floras of the northwestern United States, and Miss Eda M. Rounds of

Brown University, who is making a special study of the Carboniferous flora of Rhode Island.

Respectfully submitted,

ARTHUR HOLLICK,

Paleobotanist.

REPORT OF THE HONORARY CUSTODIAN OF THE LOCAL HERBARIUM

DR. N. L. BRITTON, Director-in-Chief.

Sir: I have the honor to present herewith my report as Honorary Custodian of the Local Herbarium for the year 1922.

The first work to be undertaken was that of sorting and arranging the sheets of the present collection, in order to make them more readily available for consultation, and also in order to discover in what parts of the local area and in reference to what species further collection is needed. Good progress has been made in this undertaking through the careful and enthusiastic labors of Mrs. P. de C. Mitchell, who has been allowed to assist the Custodian. As the time that Mrs. Mitchell can give is very limited, this work is not yet completed. Maps of the local area, one for each species, have been prepared, by the use of which the distribution of each species will be plotted for record and consultation.

Additions to the Local Herbarium have been made to the extent of about 700 sheets, by the gift from Mr. W. C. Ferguson, of Hempstead, L. I., of nearly 300 sheets, the collecting of about the same number by the Custodian, the gift of several specimens by Dr. Hollick, and the collecting of about 90 species by Mr. Beals, on Torrey Club trips.

During July and August I was enabled by the grant of $75.00 from the Charles Budd Robinson Fund, to make several trips in Orange County, in which ten of the twenty townships were visited, some specimens collected in each of these, and many desirable additions made to the Local

Herbarium. Some collecting was done also in Sullivan and Ulster Counties, in northern New Jersey, and in Connecticut.

Respectfully submitted,

H. M. DENSLOW,

Honorary Custodian of the Local Herbarium.

SCHEDULE OF EXPENDITURES DURING THE YEAR 1922

1. CITY MAINTENANCE ACCOUNT

	Appropriated	Expended	Balance
Salaries, Regular Employees	$142,839.00	$142,557.89	$281.11
Wages, Temporary Employees	12,796.80	12,796.80	
Total, Personal Service	$155,635.80	$155,354.69	$281.11
Forage and Veterinary Supplies	$373.00	$371.81	$1.19
Fuel Supplies	25,050.00	25,019.22	30.78
Office Supplies	300.00	299.43	0.57
General Plant Supplies	1,000.00	1,000.00	
General Plant Equipment	1,000.00	999.77	0.23
General Plant Materials	2,300.00	2,300.00	
General Repairs and Replacements	3,500.00	3,499.94	0.06
Light, Heat and Power	350.00	350.00	
Shoeing and Boarding Horses, including Veterinary Service	150.00	149.50	0.50
Telephone Service	150.00	149.50	0.50
Total, Expenses other than Personal Service	$34,173.00	$34.139.17	$33.83
Summary, City Maintenance Account	189,808.80	189,493.86	314.94

2. SPECIAL GARDEN ACCOUNTS

	Appropriated	Expended	Balance
PLANT FUND			
Balance from 1921	*$22.76*		
Contribution	400.00		
Sale of Hay	215.00		
Total	$637.76	$595.62	$42.14
EXPLORATION FUND			
Balance from 1921	*$19.96*		
Contribution	1,358.00		
Total	$1,377.96	$1,388.14	$10.18*
MUSEUM AND HERBARIUM FUND			
Balance from 1921	$8.62		
Contribution	110.00		
Total	$118.62	$81.35	$37.27

*Shortage

	Appropriated	Expended	Balance
SPECIAL BOOK FUND			
Balance from 1921	*$18.43*		
Sale of Books	6.75		
Total	$25.18		$25.18
SPECIAL DEVELOPMENT FUND			
Balance from 1921	*$1,108.07*		
Contributions	8,220.00		
New Paths and Grading		$3,136.00	
Engineer's and Architect's Fees		250.00	
Fencing Materials		4,043.00	
Mason Work		940.66	
Construction Supplies and Materials		435.50	
Total	$9,328.07	$8,805.16	$522.91
LOUISA COMBE BEQUEST			
Balance from 1921	*$64.52*		
Transferred to General Income Account			$64.52
EMMA CHAMBERS JONES BEQUEST			
Construction of Path Entrance on Pelham Parkway	$1,000.00		$1,000.00

3. SPECIAL INCOME ACCOUNTS

	Appropriated	Expended	Balance
Income of Science and Education Fund.			
Museum and Herbarium Specimens	$ 470.00	$351.14	$118.86
Lectures	1,330.00	1,325.95	4.05
Photography	200.00	116.45	83.55
Publications	1,000.00	937.00	63.00
Investigations at other Institutions	500.00	407.87	92.13
Total	$3,500.00	$3,138.41	$361.59
Income of Darius O. Mills Fund.			
Scientific Supplies	$2,200.00		
Laboratories		$292.96	
Museums		221.10	
Herbarium		1,428.64	
Library		168.72	
Garden		78.37	
Total	$2,200.00	$2,189.79	$10.21

	Appropriated	Expended	Balance
Income of Henry Iden Fund			
Books	$500.00		$500.00
Income of William R. Sands Fund			
Horticultural Prizes	$400.00	$152.00	$248.00
Accumulated Income of Olovia E. and Caroline Phelps Stokes Fund			
Preservation of Native Plants	$300.00	$297.71	$2.29
Accumulated Income of Students' Research Fund			
Aid for Students' Research	$850.00	$160.00	$690.00
Income of of David Lydig Fund			
Publications	$4,000.00	$3,934.41	$15.59
Income of Addison Brown Fund			
Publication of Addisonia	$3,200.00	$3,163.41	$36.59
Income of John Innes Kane Fund			
Plants for Grounds and Greenhouses	$500.00	$475.57	$24.43
Income of Maria DeWitt Jesup Fund			
Increase of the Collections, Books and Specimens	$1,200.00	$1,112.50	$87.50
Accumulated Income of Charles Budd Robinson Fund			
Aiding Exploration	$ 80.00	$75.00	$5.00
Accumulated Income of Russell Sage and Margaret Olivia Sage Fund			
Labor	$7,150.00	$7,147.60	$2.40
Library and Lantern Slide Cases	785.00	781.15	3.85
Repairs and Renewals	2,850.00	2,398.61	451.39
Salaries	19,000.00	16,365.23	2,634.77
Supplies and Materials	8,165.00	5,394.47	2,770.53
Publications	1,800.00	1,747.49	52.51
Total	$39,750.00	$33,834.55	$5,915.45
Income of Fanny Bridgham Fund			
Books and Book-binding	$1,200.00	$1,031.17	$168.83
Income of Francis Lynde Stetson Fund			
Books	$1,000.00	$183.97	$816.03

4. GENERAL INCOME ACCOUNT

	Appropriated	Expended	Balance
Insurance	$325.00	$319.94	$5.06
Entertainment of Guests and Meetings of Members	900.00	874 43	25.57
Assistance for Treasurer	1,080.00	1,080.00	
Circulars for Membership	800.00	777.87	22.13
Temporary Subsidy for Addisonia	1,000.00	953.02	46.98

	Appropriated	Expended	Balance
Contingent Fund	2,600.00	2,578.32	21.68
Salaries	16,200.00	15,843.39	356.61
Expenses of Honorary Curator of Economic Collection	600.00	600.00	
Transferred from Louisa Combe Bequest	64.52		
Totals	$23,569.52	$23,026.97	$542.55

SUMMARY OF EXPENDITURES FROM FUNDS OF THE GARDEN

	Appropriated	Expended	Balance
Special Garden Accounts		$11,870.27	
Special Income Accounts		49,798.49	
General Income Account		23,026.97	
Total		$84,695.73	

5. BOARD ROOM FUND

January 1, 1922, Balance in cash		$342.43
Gross Receipts, January to December.	$515.41	
Less, credited to Garden Funds	22.36	
Net Receipts		493.05
Total		$835.48
Disbursements, Supplies	$163.61	
Contingencies	659.47	
Total		823.08
December 31, 1922, Balance in Cash		$12.40

Respectfully submitted,
WALTER S. GROESBECK,
Bookkeeper.

E. and O. E.
NEW YORK, JANUARY 8, 1923.

DIRECTOR-IN-CHIEF'S ACCOUNT FOR THE YEAR 1922

New York, April 4, 1923

MR. ROBERT W DEFOREST
Chairman, Finance Committee, New York Botanical Garden,
30 Broad Street, New York, N. Y.

Dear Sir:

This is to certify that I have examined and audited the financial books and accounts of the Director-in-Chief of the New York Botanical Garden for the year nineteen hundred and twenty-two (1922), and that I find the same to be correct, and the cash balance to be as stated in the current cash book.

In accorance with recent practice, I have not included in the auditing the examination of the vouchers for City maintenance or construction work paid for by the City, as such vouchers have been found proper and in order by the City authorities, and it was decided in 1904 by the then Chairman of the Finance Committee that a further examination of them was unnecessary. By like authority I have omitted also a detailed examination of the annual membership dues account. These dues are received by the Director-in-Chief and forwarded by him to the Treasurer, the former keeping a detailed record of the same.

Respectfully submitted,

A. W. STONE, *Special Auditor.*

REPORT OF THE CHAIRMAN OF THE SCIENTIFIC DIRECTORS TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN

The Scientific Directors have held their regular meetings through the year and have discussed with the Director many of the matters which are presented in detail in his report.

Four additional parts of the North American Flora have been completed during the year, three on the fungi and one on the Compositae. Volume III of the great monograph of the Cactus family by Drs. Britton and Rose has appeared and more than maintains the high standards set by the two preceding volumes. With the completion of the four

volumes of this important work, we shall have produced, perhaps for the first time in America, an illustrated monograph worthy in its style and scope to be classed with the sumptuously illustrated works on the roses, orchids, etc., of the old world botanists. The Dahlia Border, the new Iris Garden, the Rose Garden, and the Holland Bulb Growers spring exhibition of tulips have been notable again this year for the variety and excellence of the types displayed. In these plantings of horticultural and decorative plants the Garden is doing much to stimulate a keener and more discriminating interest in the newer as well as the standard products of the plant breeder's art. The publication by Dr. Howe in Addisonia of popular, but scientifically accurate and adequate, descriptions of an especially noteworthy series of dahlias with illustrations from Miss Eaton's beautiful paintings, is another notable contribution in the same field.

For a number of years past the Scientific Directors have been increasingly impressed with the need of larger funds for the support of the scientific and educational work of the Garden if it is to do its full share in the advancement of botanical science. Funds are needed both for the exploration of the floras and plant resources of the botanically less-known parts of the world, especially Central and South America, and for work in the great fields of experimental plant pathology, physiology and genetics. With our present limited staff and equipment, it is quite impossible, for example, to take adequate advantage of the very special opportunities for genetical, physiological and pathological studies which both the decorative and systematic plantations at the Garden afford. This matter has been fully presented in the report of the Budget Committee and of the Director, and the Scientific Directors agree most earnestly in urging the importance of the plans presented for increasing the endowment of the Garden.

Respectfully submitted,

R. A. HARPER, *Chairman.*

REPORT OF THE COMMITTEE ON PATRONS FELLOWS AND MEMBERS FOR THE YEAR 1922.

To the Board of Managers of the New York Botanical Garden.

Gentlemen: The number of new members who have qualified is 187. The number of annual members is now 1257; life members 127; sustaining members 17.

Of the annual members 46 are now in arrears for dues for 1922, 28 for dues 1921 and 1922, 6 for dues for 1920, 1921 and 1922.

Dues have been collected to the amount of $12,460.

Three persons have qualified as life members by the payment of $250 each. Two fellowship members have completed their payments of $100 per year for ten years and have been enrolled as fellows for life. These sums have been transmitted to the treasurer.

A complete list of all classes of members to date is herewith submitted.

Benefactors

*Mrs. Fanny Bridgham,
*Hon. Addison Brown,
*Andrew Carnegie,
Columbia University,
*Hon. Charles P. Daly,
Daniel Guggenheim,
Murry Guggenheim,
*D. O. Mills,
*J. Pierpont Morgan, Sr.,
John D. Rockefeller,
*Mrs. Russell Sage,
*Francis Lynde Stetson,
*Cornelius Vanderbilt.

Patrons

Oakes Ames,
*Miss Catherine A. Bliss,
Dr. N. L. Britton,
*Hon. Addison Brown,
*Andrew Carnegie,
*Mrs. George Whitfield Collord,
*Mrs. Louisa Combe,
*James M. Constable,
*William E. Dodge,
James B. Ford,
George J. Gould,
Edward S. Harkness,
*Mrs. Esther Herrman,
Archer M. Huntington,
*Henry Iden,
Mrs. John Innes Kane,

* Deceased

*John Stewart Kennedy,
*Mrs. Mary J. Kingsland,
*J. Pierpont Morgan, Sr.,
*Oswald Ottendorfer,
*Lowell M. Palmer,
*William Rockefeller,
*William R. Sands,
*William C. Schermerhorn,
*James A. Scrymser,
Mrs. Finley J. Shepard,
*Samuel Sloan,
Mrs. Frederick F. Thompson,
*W. K. Vanderbilt,
Mrs. Antoinette Eno Wood.

Fellows for Life

Edward D. Adams,
George F. Baker,
Miss Elizabeth Billings,
Mrs. W. Bayard Cutting,
Dr. Robert W. de Forest,
Cleveland H. Dodge,
James B. Ford,
Daniel Guggenheim,
Murry Guggenheim,
S. R. Guggenheim,
Mrs. John Stewart Kennedy,
Edward V. Z. Lane,
Mrs. Frederic S. Lee,
Ogden Mills,
J. P. Morgan,
E. A. Richard,
Mrs. John A. Roebling,
Mortimer L. Schiff,
Leon Schinasi,
Miss Olivia E. Phelps Stokes,
Charles G. Thompson,
Louis C. Tiffany,
Tiffany & Company.

Life Members

Edward D. Adams,
Dr. Felix Adler,
Mrs. James Herman Aldrich,
J. Sherlock Andrews,
Dr. S. T. Armstrong,
Edward W. C. Arnold,
Mrs. H. D. Auchincloss,
Samuel D. Babcock,
Dr. John Hendley Barnhart,
George D. Barron,
Aurel Batonyi,
Gustav Baumann,
Samuel R. Betts,
William G. Bibb,
Miss Elizabeth Billings,
Mrs. Robert Woods Bliss,
George Blumenthal,
G. T. Bonner,
Mrs. Addison Brown,
J. Hull Browning,
Mrs. Andrew Carnegie,
T. Morris Carnegie,
Frank R. Chambers,
Hugh J. Chisholm,
Hugh J. Chisholm, Jr.,
Geo. C. Clark,
Banyer Clarkson,
Dr. James B. Clemens,
William F. Cochran,
W. R. Coe,
William Colgate,
Miss Georgette T. A. Collier,

* Deceased

W. E. Conner,
Mrs. F. A. Constable,
Zenas Crane,
R. N. Cranford,
Charles Deering,
Mrs. John Ross Delafield,
Maturin L. Delafield,
W. B. Dickerman,
Miss Josephine W. Drexel,
Miss Ethel DuBois,
Miss Katharine DuBois,
William A. DuBois,
George E. Dunscombe,
Thomas Dwyer,
George Ehret,
Ambrose K. Ely,
Edward J. Farrell,
Mrs. H. J. Fisher,
Andrew Fletcher,
Charles R. Flint,
Eugene, G. Foster,
Mrs. John French,
Mrs. Theodore Kane Gibbs,
Daniel Guggenheim,
Bernard G. Gunther,
Franklin L. Gunther,
Charles J. Harrah,
Dr. Louis Haupt,
R. Somers Hayes,
Archer M. Huntington,
Frank D. Hurtt,
James H. Hyde,
Mrs. Columbus O'D. Iselin,
Theo. F. Jackson,
Dr. Walter B. James,
Miss Annie B. Jennings,
Mrs. David J. Kelley,
Nathaniel T. Kidder,
H. R. Kunhardt,
W. B. Kunhardt,
Charles Lanier,
W. V. Lawrence,
Meyer H. Lehman,
Mrs. George Lewis,
Joseph Loth,
William H. Macy, Jr.,
Louis Marshall,
Edgar L. Marston,
William J. Matheson,
C. W. McAlpin,
Guy R. McLane,
Emerson McMillin,
Dr. George N. Miller,
A. G. Mills,
Mrs. William F. Milton,
Dr. Lewis R. Morris,
Sigmund Neustadt,
A. Lanfear Norrie,
Gordon Norrie,
George M. Olcott,
Mrs. Charles Tyler Olmstead,
William Church Osborn,
W. H. Perkins,
Gustavus A. Pfeiffer,
M. Taylor Pyne,
John J. Riker,
J. C. Rodgers,
Thomas F. Ryan,
Mrs. Herbert L. Satterlee,
Dr. Reginald H. Sayre,
Edward C. Schaefer,
Mortimer L. Schiff,
Mrs. I. Blair Scribner,
George Sherman,
James Shewan,
James Speyer,
Miss Ellen J. Stone,
Albert Tag,
Paul G. Thebaud,
Charles G. Thompson,

Mrs. Frederick F. Thompson,
Robert M. Thompson,
William Thorne,
William Stewart Todd,
Miss Anna Murray Vail,
F. T. Van Beuren,
Mrs. C. Vanderbilt,
F. M. Warburg,
John I. Waterbury,
Miss Emily A. Watson,
S. D. Webb,
Dr. W. Seward Webb,
John D. Wing,
Mrs. Anna Woerishoffer.

Sustaining Members

Robert Breckinridge Baird,
Miss Elizabeth Billings,
Miss Mary T. Bryce,
Homer A. Dunn,
John Greenough,
Mrs. E. V. C. Hawkes,
O. H. Kahn,
Mrs. Frida Merz Krollpfeiffer,
Edgar L. Marston.
George Grant Mason,
Arthur M. Mitchell,
William Church Osborn,
William H. Porter,
Mrs. James T. Pyle,
William R. Stewart,
Charles Strauss.
Arthur Hays Sulzburger.

Annual Members

Dr. Robert Abbe,
Benjamin Abert,
Fritz Achelis,
John Achelis,
F. B. Adams,
Henry S. Adams.
Mrs. George B. Agnew,
Alcuin Preparatory School,
J. E. Aldred,
Mrs. Winthrop W. Aldrich,
Sir Douglas Alexander, Bart.,
Mrs. Frances Gordon Alexander
Mrs. John E. Alexandre,
James F. Allen,
Philip Allen,
Mrs. S. W. Allerton,
Miss Clara Altschul,
Mrs. O. P. Amend,
P. Chauncey Anderson,
J. M. Andreini,
Miss Charlotte L. Andrews,
W. H. Andrews,
John F. Anglin,
D. A. Ansbacher,
Mrs. John F. Archbold,
Mrs. George A. Archer,
Francis J. Arend,
Reuben Arkush,
Mrs. H. O. Armour,
Dr. William Aronstein,
B. M. Asch,
Mrs. M. Ascher,
E. Asiel,
Dr. John Aspell,
Mrs. E. S. Auchincloss,
Mrs. E. S. Auchincloss, Jr.,
John W. Auchincloss,
Chellis A. Austin,
Ledyard Avery,
Charles F. Ayer,

Frank L. Babbott,
Jules S. Bache,
Charles Baird,
Miss Charlotte S. Baker,
George F. Baker,
Stephen Baker,
Albert H. Baldwin,
A. T. Baldwin,
Frederick H.Baldwin,
George V. N. Baldwin, Jr.,
William D. Baldwin,
Mrs. William M. Baldwin,
Edward L. Ballard,
Chris Bambach,
Louis Bamberger,
Mrs. James L. Barclay,
Percival M. Barker,
Julius H. Barnes,
William M. Barnum,
Clarence W. Barron,
Miss Mary F. Bartlett,
John E. Bates,
Mrs. A. Battin,
Mrs. Martha Battle,
Felice Bava,
Mrs. L. P. Bayne,
Jeremiah Beall,
John D. Beals,
Lewis Bechtold,
Mrs. Margaret B. Becker,
H. C. Beckman,
Frank Begrisch, Jr.,
Mrs. A. Frederick Behre,
Dr. Otto F. Behrend,
Frank N. Bell,
Louis V. Bell,
William B. Bell,
C. M. Bellek,
August Belmont,
J. Philip Benkard,
Bruno Benziger,
Mrs. Charles F. Berger,
E. R. T. Berggren,
Isaac J. Bernheim,
Charles L. Bernheimer,
Miss Rosie Bernheimer,
Theodore Bernstein,
Philip Berolzheimer,
Edward J. Berwind,
George N. Best,
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Miss Fanny A. Smith,
James B. Smith,
Dr. Nelson Smith,
Pierre J. Smith,
Mrs. R. Penn Smith Jr.,
Mrs. Christopher D. Smithers,
B. E. Smythe,
Frederick Snare,
E. G. Snow,
Frederic A. Soldwedel,
Phineas Sondheim,
B. Souto,
William M. Spackman,
Mrs. Edward W. Sparrow,
Mrs. Gino C. Speranza,
Mrs. B. G. Spiegelberg,
Dr. Edward H. Squibb,
A. T. Stanley,
Mrs. Mary P. Eno Steffanson,
Mrs. J. Rich Steers,
Fred T. Steinway,
William R. Steinway,
Olin J. Stephens,
Roderick Stephens,
Benjamin Stern,
Sereno Stetson,
Edward R. Stettinius,
Mrs. Byam K. Stevens,
Frederic W. Stevens,
Lispenard Stewart,
Chauncey Stillman,
Miss Clara F. Stillman,
C. C. Stillman,
Alfred W. Stone,
Mrs. Charles H. Stout,
Mrs. Willard Straight,
Mrs. C. I. Stralem,
H. Grant Straus,
Mrs. Nathan Straus, Jr.,
Roger W. Straus,

Albert Strauss,
Frederick Strauss,
Martin Strauss,
Samuel Strauss,
Mrs. William Strauss,
William H. Strawn,
Dr. George T. Strodl,
Mrs. Gustaf Stromberg,
Benjamin Strong, Jr.,
John R. Strong,
Nat. C. Strong,
Richard A. Strong,
Mrs. Theron G. Strong,
Joseph Stroock,
Louis S. Stroock,
Duncan Struthers,
Frank K. Sturgis,
Mrs. James Sullivan,
Frank M. Swacker,
Harry Swan,
Mrs. J. Andrew Swan,
Maurice Switzer,
Miss Mary Taber,
Henry W. Taft,
E. T. H. Talmage,
Charles G. Taylor,
Henry R. Taylor,
Dr. Richard A. Taylor,
W. A. Taylor,
H. L. Terrell,
Charles T. Terry,
Mrs. John T. Terry,
H. B. Thayer,
E. Thiele,
Mrs. Hector W. Thomas,
Mrs. Howard L. Thomas,
Percival Thomas,
Loren Ogden Thompson,
L. S. Thompson,
William B. Thompson,
Dr. W. Gilman Thompson,
Miss Evelyn May Thomson,
Samuel Thorne, Jr.,
Louis C. Tiffany,
Henry N. Tifft,
Dr. Walter Timme,
James Timpson,
Mrs. Norman E. Titus,
Rev. E. P. Tivnan, S. J.,
Mrs. Margaret T. Tjader,
J. Kennedy Tod,
Edward R. Tolfree,
Nesib Trabulsi,
W. C. Tragesor,
Mrs. Heaton Ives Treadway,
Mrs. John B. Trevor,
A. F. Troescher,
John Trounstine,
E. Kellogg Trowbridge,
Carll Tucker,
Dr. Alfred Tuckerman,
Paul Tuckerman,
Dr. Joseph Tunik,
Edward Turnbull,
Mrs. Harold M. Turner,
George E. Turnure,
Mrs. Mary A. Tuttle,
Mrs. Alice B. Tweedy,
E. S. Twining,
Lucien H. Tyng,
August Uhl,
Oswald W. Uhl,
Mrs. Walter M. Underhill,
Mrs. Henry C. Valentine,
James J. Van Alen,
Mrs. Frederick T. Van Beuren,
Augustus Van Cortlandt,
Barend Van Gerbig,
John B. Van Haelen,
Mrs. Stephen G. Van Hoesen,

E. H. Van Ingen,
Gilbert Van Ingen,
Mrs. Harriet Van Ingen,
Dr. Philip Van Ingen,
Mrs. Warner M. Van Norden,
Mrs. E. Van Raalte,
Mrs. Wilbur Linwood Varian,
Mrs. James M. Varnum,
Mrs. A. C. Veatch,
Thomas F. Vietor,
Alfonso P. Villa,
G. B. Vitelli,
Ludwig Vogelstein,
Mrs. Owen M. Voight,
Dr. S. Wachsmann,
Montgomery Waddell,
Mrs. W. Austin Wadsworth,
Mrs. J. Howard Wainwright,
Justus I. Wakelee,
Dr. Alfred Walker,
Mrs. Joseph Walker, Jr.,
William I. Walker,
Mrs. W. K. Wallbridge,
Leo Wallerstein,
Dr. Max Wallerstein,
Mrs. James W. Walsh,
William I. Walter,
Artemus Ward,
C. Blaine Warner,
Mrs. Charles Howard Warren,
Mrs. John I. Waterbury,
C. W. Watson,
Mrs. J. E. Watson,
Mrs. E. H. Weatherbee,
Mrs. V. Webb,
Mrs. W. Seward Webb,
Miss Alice D. Weekes,
R. L. Wegel,
Dr. Eugene Wehmeyer,
George A. Weigel,
Charles H. Weigle,
Mrs. Samuel W. Weiss,
Mrs. John Wells,
Oliver J. Wells,
William Y. Wemple,
Arthur L. Wessell,
Dr. William West,
Miss Edith Wetmore,
Mrs. George C. Wheeler,
Dr. Wm. E. Wheelock,
Miss Caroline White,
Mrs. E. Lawrence White,
Harold T. White,
Mrs. William T. White,
Alfred A. Whitman,
Clarence Whitman,
Howard Whittemore,
F. B. Wiborg,
Miss F. E. Wickham,
Mrs. D. O. Wickham,
William G. Willcox,
Mrs. Fred Willenbrock,
Elmore A. Willets,
Mrs. Percy H. Williams,
Richard H. Williams,
William H. Williams,
W. P. Willis,
James R. Williston,
Frank D. Wilsey,
Prof. Edmund B. Wilson,
Dr. Margaret B. Wilson,
M. Orme Wilson,
Charles A. Wimpfheimer,
Harold Wingate,
Bronson Winthrop,
Grenville L. Winthrop,
Mrs. Robt. Winthrop,
John C. Wister,
Mrs. Frank S. Witherbee,
Joseph Wittman,

Dr. William H. Woglom,
Fred R. Wolff,
Lewis S. Wolff,
M. Wolff,
Mrs. T. Wolfson,
Mrs. William H. Woodin,
Prof. R. S. Woodward,
Miss Julia Wray,
Mrs. J. Hood Wright,
Dr. Peter B. Wyckoff,
Dr. George A. Wyeth,
Mrs. A. Murray Young,
George A. Zabriskie,
Henry C. Zaro,
Mrs. Anna M. von Zedlitz,
Charles H. Zehnder,
August Zinsser,
Charles Zoller,
Henry Zuckerman.

Members of the Women's Auxiliary

Mrs. George A. Armour,
Mrs. Robert Bacon,
Miss Elizabeth Billings,
Mrs. N. L. Britton,
Mrs. Charles D. Dickey,
Mrs. A. Barton Hepburn,
Mrs. Robert C. Hill,
Mrs. Walter Jennings,
Mrs. Bradish Johnson,
Mrs. Delancey Kane,
Mrs. Gustav E. Kissel,
Mrs. A. A. Low,
Mrs. V. Everit Macy,
Mrs. Henry Marquand,
Mrs. George W. Perkins,
Mrs. George D. Pratt,
Mrs. Harold I. Pratt,
Mrs. William A. Read,
Mrs. James Roosevelt,
Mrs. Benson B. Sloan,
Mrs. Theron G. Strong,
Mrs. Edw. T. H. Talmage,
Mrs. Henry O. Taylor,
Mrs. W. Gilman Thompson,
Mrs. George Cabot Ward.

Honorary Members of the Women's Auxiliary

Mrs. E. Henry Harriman,
Mrs. John I. Kane,
Mrs. James A. Scrymser,
Miss Olivia E. P. Stokes,
Mrs. F. F. Thompson.

REPORT OF THE TREASURER

NEW YORK, January 8, 1923

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: I transmit herewith the Treasurer's Report from January 1 to December 31, 1922, showing a statement of the receipts and disbursements, and Balance Sheet from my Ledger as of December 31, 1922.

Respectfully submitted,

JOHN L. MERRILL,
Treasurer.

RECEIPTS AND DISBURSEMENTS

Receipts

Balance, January 1, 1922		$45,474.25
Income from General Investments		23,681.25
Income from Investment Sage Fund		34,655.54
Contributions from New York City		178,214.29
Income from Special Funds		
David Lydig Fund	2,344.10	
Stokes Fund	42.70	2,386.80
Contributions		
Plant Fund	$ 615.00	
Special Development Fund	8,220.00	
Sustaining Members	425.00	
Annual Dues	11,815.00	
Fellowship Members' Dues	200.00	
Subscriptions to Addisonia	2,438.19	
Students' Research Fund	128.00	
Life Membership Fees	750.00	
Museum and Herbarium	110.00	
Special Book Fund	6.75	
Exploration Fund	1,358.00	26,065.94
Refunds		
Miscellaneous Sales		$403.44
Interest on Deposits		1,417.16

Investments		
Sage Fund, received from the Sage Estate		
Sales of securities for purposes of reinvestment in higher grade securities		$128,674.58
Margaret Olivia Sage Fund, second distribution to residuary legatees		
Value of securities	$108,577.26	
Accured interest (prin.)	917.56	
Taxes	3,232.47	
Cash	37,272.71	150,000.00
		$590,973.25

Disbursements

Paid through Director-in-Chief		
Account of City appropriations	$178,214.29	
Special Book Fund	24.20	
Vouchers Paid	21,588.56	
Special Development Fund	10,348.16	
Museum and Herbarium	121.35	
Plant Fund	418.85	
Louisa Combe Bequest	160.00	
Exploration Fund	1,349.92	
Account Income of Kane Fund	349.62	
Account Income of Addison Brown Fund	2,999.97	
Account Income of Students' Research Fund	135.00	
Account Income of Lydig Fund	3,122.68	
Account Income of Sage Fund	32,338.17	
Account Income of Science and Education Fund	2,494.49	
Account Income of Iden Fund	190.00	
Account Income of Jesup Fund	1,212.55	
Account Income of Mills Fund	2,543.23	
Account Income of Stokes Fund	156.12	
Account Income of Bridgham Fund	1,045.92	
Account Income of Sands Fund	152.00	

Account Income of Robinson Fund	$75.00	
Account Income of Stetson Fund..	143.98	$259,184.06
Income General Investments		
Adjustments of Interest of purchase and sale of securities.....	$ 152.70	
Annual payment to Mrs. Staples, in accordance with agreement	1,000.00	
Part commission to New York Trust Company for collecting income.....	57.33	1,210.03
Income Investments Sage Fund		
Accrued Interest paid upon purchase of securities.....	$3,219.34	
Commission to New York Trust Company for collecting income.	57.33	3,276.67
General Investments		
Purchase of $25,000 Provident Loan Society Certificates at par.....		25,000.00
Margaret Olivia Sage Fund		
Taxes charged against legacy.....		3,232.47
Investment Sage Fund		
Value of Securities received from Sage Estate (second distribution)	108,577.26	
Investments, purchase of securities.....	169,844.25	278,421.51
Balance		
New York Trust Co.....	9,217.42	
J. P. Morgan & Co.....	11,431.09	20,648.51
		$590,973.25

Ledger Balances, December 31, 1922

Permanent Funds	*Debit*	*Credit*
Endowment Fund.....		$270,010.00
Endowment Fund for Science & Education....		83,461.90
David Lydig Fund.....		34,337.86
William R. Sands Fund.....		10,000.00

Francis L. Stetson Fund		$25,000.00
Darius O. Mills Fund		50,000.00
Charles P. Daly Trust Fund		19,636.34
Henry Iden Fund		10,000.00
Addison Brown Fund		21,850.00
John Innes Kane Fund		10,000.00
Stokes Fund		3,000.00
Charles Budd Robinson Memorial Fund		705.94
Students Research Fund		4,488.00
Maria DeWitt Jesup Fund		25,000.00
Margaret Olivia Sage Fund		596,280.13
Fanny Bridgham Fund		30,000.00
General Investments		
As per Schedule A	$521,488.86	
Investment Sage Fund		
As per Schedule B.	605,514.18	
Profit and Loss on Sales General Investments		1,618.03
Profit and Loss on Sales Sage Fund		25,399.32
Temporary Funds		
Reserve Fund	12,020.32	
Emma C. Jones Bequest		1,000.00
Special Book Fund		25.14
Special Development Fund		1,277.31
Plant Fund		468.82
Exploration Fund		28.04
Museum & Herbarium Fund		37.27
General Income	$23,837.75	
Income Accounts		
Income of Maria DeWitt Jesup Fund		379.86
Income of David Lydig Fund	3,231.21	
Income of Darius O. Mills Fund	437.98	
Income of Stokes Fund		317.75
Income of Students Research Fund		883.19
Income of Science & Education Fund		1,251.23
Income of John Innes Kane Fund		565.73
Income of Henry Iden Fund	461.11	
Income of Addison Brown Fund		317.96

Income of William R. Sands Fund.....		$203.58
Income of Charles B. Robinson Memorial Fund		50.07
Income of Margaret Olivia Sage Fund.....	10,923.16	
Income of Fanny Bridgham Fund.....		141.42
Income of Francis Lynde Stetson Fund.....		828.19
Director-in-Chief, working Fund.....	30,000.00	
Cash Balance, December 31, 1922....	20,648.51	
	$1,228,563.08	$1,228,563.08

General Investments

Schedule A.

$50,000 Ches. & Ohio Ry. 4½'s.....	$47,875.00
$50,000 Southern Ry. 5's.....	54,604.17
$50,000 Eries Ry. 4's.....	46,145.84
$59,000 Erie Ry. 4's.....	54,713.75
$24,000 U. S. Govt. 2nd Liberty Loan Bonds 4¼'s.	24,060.00
$50,000 Reading Ry. 4's.....	46,750.00
$10,000 New York City 4's.....	9,936.25
$50,000 Penn. Ry. 4½'s.....	50,500.00
$10,000 New York Cent. Ry.....	9,510.48
$10,000 Balto. & Ohio Ry. 5's.....	10,025.00
$11,000 Milw. Sparta & N. W. Ry. 4's.....	10,120.00
$37,000 Nor. Pac. Ry. 4's.....	34,058.75
$10,000 Third Liberty Loan.....	10,000.00
$35,000 Great Nor. Ry. 7's.....	33,775.00
$50,000 Provident Loan Soc. Ctfs.....	50,000.00
$ 1,000 New York City 4¼'s.....	990.00
$ 9,000 New York City 4's.....	8,718.75
$10,000 Niagara Falls Power Co.....	9,550.00
$ 5,000 Nash. Chat. & St. Louis Ry. Equip. 6's....	5,069.85
$ 5,000 Cin. N. O. & Texas Ry. Equip. 6's.....	5,086.02
	$521,488.86

Investments of Sage Fund

Schedule B.

Stocks

52 Shares Bankers Trust Co.	$19,500.00
250 Shares U. S. Steel Pfd.	27,359.37
10 Shares Importers & Traders National Bank. . . .	5,600.00
480 Shares American Telephone & Telegraph Co. .	45,775.00
200 Shares Atch. Top. & St. Fe Pfd.	14,525.00
100 Shares Mo. Kan. & Tex. Ry. Pfd. (with asses't.)	3,208.00
100 Shares American Tel. & Cable Co.	5,075.00
100 Shares Union Pacific Ry. Pfd.	6,237.50

Bonds

$10,000 Oregon, Wash. R. R. & Nav.	6,500.00
$19,000 N. Y. Telephone 1st. Gen.	14,155.00
$ 6,000 Balto. & Ohio P. L. 3½'s.	4,860.00
$7,000 Wash. Terminal 1st 3½'s.	4,830.00
$15,000 Mich. Centr. Eq. 6's.	15,193.50
$10,000 N. Y. Central Eq. 6's.	10,163.02
$15,000 Chic. & No. Western Ry. Eq. 6's.	15,228.49
$15,000 Southern Ry.	11,962.50
$15,000 Illinois Central Eq. 6's.	15,211.49
$15,000 Atlantic Coast Line Cons. Mtge.	12,112.50
$15,000 Union Pacific 1st & L. G.	12,637.50
$15,000 Chic. Burl. & Quincy Gen. Mtge.	12,112.50
$15,000 Norf. & Western Ry. 1st Cons. Mtge. . . .	12,037.50
$15,000 N. Y. Central Ry. Cons. Mtge. 4's.	11,212.50
$10,000 Pac. Gas & Electric Co.	8,925.00
$10,000 Illinois Central Eq. 6's.	10,128.08
$10,000 Chic. & No. Western Eq. 6's.	10,151.50
$10,000 Pitts. McK. & Yough. Eq. 6's.	10,151.50
$10,000 Nash. Chatt. & St. L. Ry. Eq. 6's.	10,162.24
$10,000 Cin. N. Orleans & Tex. Pac. Eq. 6's.	10,181.97
$10,000 N. Y. Telephone Ref. Mtge.	10,040.00
$ 1,000 Gen. Electric Gold Deb.	971.50
$ 4,000 Gen. Electric Gold Deb.	3,866.00
$ 9,000 Amer. Smelt. & Ref. 1st Mtge.	7,809.75
$ 1,000 Amer Smelt. & Ref. 1st Mtge.	871.50
$ 5,000 General Electric Co.	4,838.75

$20,000 Louisville & Nash. Ry. Eq. 6's.....	$20,302.63
$20,000 Atlantic Coast Line Eq. 6's.....	20,363.64
$50,000 Provident Loan Soc. Ctfs.....	50,000.00
$35,000 Norfolk & Western 4's.....	30,931.25
$11,000 New York Central 4's.....	9,253.75
$13,000 Northern Pacific 4's.....	11,293.75
$15,000 Chic. Burl. & Quincy 4's.....	13,481.25
$30,000 Commercial Cable Co. 4 s.....	22,500.00
$ 5,000 Liggett & Myers 5's.....	4,938.75
$15,000 P. Lorillard 7's.....	17,437.50
$10,000 New Brunswick Southern 1st 3's.....	8,100.00
$ 2,000 Minn. St. Paul & Sault St. M. 1st. 4's.....	1,735.00
$ 5,000 Rochester Ry. & Light 5's.....	4,475.00
$ 4,000 Balt. & Ohio Wn. Div. 1st 3½'s.....	3,490.00
$ 6,000 Buffalo Gen'l. Electric 1st 5's.....	5,640.00
$ 4,000 N. Y. Central Ry. 4's.....	3,165.00
$ 4,000 Chic. Rock Is. & Pac. Ry. 4's.....	3,070.00
$ 2,000 Pennsylvania Ry. Co. Gen. 4½'s.....	1,742.50
	$605,514.18

Treasurer's Account for the Year 1922

New York, April 4, 1923

Mr. Robert W. deForest
Chairman, Finance Committee, New York Botanical Garden
30 Broad Street, New York, N. Y.

Dear Sir:

This is to certify that I have, by direction of the Board of Managers, examined the books and accounts of the Treasurer of the New York Botanical Garden, for the year nineteen hundred and twenty-two (1922), together with their proper vouchers, and that I find the balance sheet and the Treasurer's statement of receipts and disbursements attached hereto to be correct.

The various investment securities have also been verified and accounted for, and I certify that the statement of the same reported in the balance sheet of December 31, 1922, is correct.

Respectfully submitted,

A. W. Stone,
Special Auditor.

VOL. 12 No. 44

BULLETIN

OF

THE NEW YORK BOTANICAL GARDEN



ISSUED MAY 28, 1924

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BULLETIN
OF
The New York Botanical Garden

Vol. 12 No. 44

REPORT OF THE SECRETARY AND DIRECTOR-IN-CHIEF FOR THE YEAR 1923

(*Accepted and ordered printed January 14, 1924*)

To the Board of Managers of The New York Botanical Garden.

Gentlemen: I have the honor to submit my report for the year ending January 14, 1924.

The most noteworthy incident of the year was our purchase from the Botanical Garden of the City of Geneva, Switzerland, of the most important collection of books on botany and horticulture which has ever passed from the Old World to the New. These books were in duplicate at the library of the Geneva garden, and were offered for sale *en bloc* for 72,000 Swiss francs, about $13,000; the number of bound volumes is about 5,000, of pamphlets and unbound volumes as many or more. The books were received in August in 93 packing cases weighing in all over 12 tons. Dr. Barnhart and Miss Harlow have made considerable progress in classifying and shelving them, requiring much time and work. Additional steel library shelving was required and obtained, and more has been ordered. The purchase was made possible by subscriptions of members of the Garden to the fund for scientific and educational purposes.

The Rose Garden, with over 4,500 plants, representing about 240 varieties, has, under the supervision of Mr. Kenneth R. Boynton, Head Gardener, enjoyed its most effective year. Special attention has been given to vari-

eties with a second or a long-extended period of flowering, so that amateur rose growers visiting the Garden are given practical demonstrations of the fact that June is not of necessity the only "month of roses." We are indebted to Messrs. Bobbink and Atkins for the gift of several hundred rose bushes, including 200 plants of 100 climbing varieties which were planted in the late autumn. For the support of these climbing varieties red-cedar posts and pillars have been set. The addition of these varieties with their masses of bloom in June and July is destined to double the effectiveness and general popularity of the Rose Collection. A series of single wild roses has also been planted near the rambling roses at the southern end of the Rose Garden.

One of the most notable developments of the year has been that of the Rock Garden under the devoted supervision of Dr. Edmund Bronk Southwick. The Rock Garden is located to the south of the Herbaceous Grounds and to the northwest of the Iris Garden. A ridge of glaciated rock constitutes its axis and foundation. On the slopes and around the base of this ledge hundreds of boulders have been set and about them the kinds of soil best suited to various kinds of alpine and rock-loving plants have been introduced. Nearly 1,000 species of European, Asiatic, and American rock and alpine plants have already been established, including the Swiss edelweiss and numerous kinds of stonecrop, houseleek, saxifrage, rock cress, columbine, hepatica, sandwort, mountain pink, lobelia, alpine thistle, wild thyme, aubrietia, violet, and many others. The Rock Garden includes some of the earliest-flowering as well as some of the latest-flowering of our hardy plants, and is destined to become one of the most popular and instructive of our plantations.

The collection of dahlias, including 853 plants representing about 450 of the choicest modern varieties, under the direction of Dr. Marshall A. Howe, continued to offer one of the most popular floral displays in the Garden.

The dahlia border is visited not only by the general public of New York and vicinity, but also by amateur growers and experts from various parts of the country. It is doing much to educate the public as to the decorative possibilities of the modern developments of this popular flower.

By favor of the Dutch Bulb Growers' Association, 80,500 tulip bulbs of 154 varieties were planted in the autumn and these are expected to make great floral displays in the spring, in the Horticultural Grounds, where 43,000 Darwin tulips have been set, and in the court of conservatory range No. 1, where some 37,000 of the earlier-flowering types were planted.

Other special horticultural collections have been increased both in the number of varieties of plants grown and in the effectiveness of display. The Iris Collection, formed in coöperation with the American Iris Society, has been brought to include over 1,200 named kinds; about 90 kinds of Paeonies, 70 kinds of hardy Chrysanthemums and 60 of tender Chrysanthemums, mostly given by Elmer D. Smith and Company, have been shown and the Lilac Collection has been increased to 185 varieties. Over 6,000 Narcissus bulbs were planted in the southern part of the Horticultural Grounds.

Study of the wild plants of the vicinity of New York has been stimulated by attention given by Dr. Denslow and by Mrs. Mitchell to the rearrangement and increase of the Local Herbarium in coöperation with members of the Torrey Botanical Club. The importance of the preservation of native plants has been emphasized by Mrs. Britton's work in coöperation with the Wild Flower Preservation Society of America, aided by the increase of the Stokes Fund for the Preservation of Native Plants. An article in the November number of the *Journal* by Dr. George F. Norton on "How to Have Fringed Gentians," with an offer to furnish seed free of charge, together with a similar offer by Dr. Stout, in the *New York Evening Post*, has resulted in nearly a hundred applications for seed,

which will doubtless do something to restore the former abundance of this highly prized and locally vanishing flower.

Our investigation of the plants of the Cactus Family, prosecuted during the past ten years in coöperation with the Carnegie Institution of Washington and the Smithsonian Institution, was completed by the publication of the fourth volume of the monograph of Cactaceae. This work, written by N. L. Britton and J. N. Rose, and published in quarto by the Carnegie Institution, elegantly printed and illustrated, is the most complete treatise on these plants and the most noteworthy monograph of an order of plants as yet produced in America. It was made possible by the facilities of our greenhouses, museums, herbarium, and library and by the artistic ability of Miss Mary E. Eaton of our staff.

The botanical study of Florida, continued by Dr. Small with the highly valued coöperation of Mr. Charles Deering, has added much to the knowledge of vegetation of the southeastern United States, and has enriched our collections of plants and of specimens. The more accurate knowledge of the southern species of *Iris* is one of Dr. Small's more recent contributions to botany and horticulture.

The investigation of the vegetation and plant products of northern South America, prosecuted for several years in coöperation with the United States National Museum and the Gray Herbarium of Harvard University is yielding results of high scientific value and adding greatly to the reference strength of our collections. Important additions were made during the year by many specimens obtained in Venezuela by Mr. W. E. Broadway and by Mr. H. Pittier, and in Ecuador by Mr. A. S. Hitchcock. Highly valued coöperation of Captain Arthur W. Hill, Director of the Royal Gardens at Kew, England, provided opportunity for us to secure nearly 3,000 specimens collected some years ago by E. André in Colombia and Ecuador, and through an important exchange arranged with Professor H. Lecompte, Director of the Jardin des Plantes, Paris, many

specimens from French Guiana were obtained. Dr. Gleason has been referred to curatorial work on these collections, including the many thousand specimens previously obtained and recorded in previous reports.

Dr. Rusby has given much time to the classification of the large Bolivian collection made by him in 1921–22 while directing the Mulford Exploring Expedition. These specimens, together with the several collections previously obtained from that country by Dr. Rusby and others, make our representation of Bolivian plants and their products the most complete in existence.

The first and second parts have appeared of the "Botany of Porto Rico and the Virgin Islands," written by N. L. Britton and Percy Wilson and published by the New York Academy of Sciences. This work, based mainly upon the large collections obtained for our greenhouses, herbarium, and museum through exploring expeditions to the West Indies during the past twenty years, contributes English descriptions, for the first time, of the plants, both wild and cultivated, inhabiting the Caribbean islands of the United States.

Continued investigation of reef-building seaweeds, both living and fossil, by Dr. Howe, have supplemented his highly important earlier scientific contributions to this subject, and have added many valuable specimens to our collection of these organisms, which is now the most extensive in America.

Studies by Dr. Hollick of the fossil plants obtained during our exploration work in the West Indies, including collections from Cuba, Santo Domingo, Porto Rico, and Trinidad, give us our first considerable knowledge of the ancestors of existing West Indian vegetation, an important contribution to knowledge, written for publication in our *Bulletin*.

During the first half year, Dr. A. B. Stout, Director of the Laboratories, was in southern California on a leave of absence, with the consent and approval of the Board of Managers. While there, he gave occasional lectures at

Pomona College and conducted investigations on sterility and fertility in relation to several of the important fruit-crops. The results of his studies of numerous varieties of avocado ("alligator pear") in regard to the periodicity of the opening and sexual maturity of their flowers were especially remarkable. Dr. Stout's researches showed clearly just which varieties should be planted together to secure pollinations and the consequent setting of fruit. These practical results mean hundreds of thousands of dollars to the avocado-growers of California and of the world at large. Dr. Stout's work in extending our knowledge of the habits of plants and in applying this knowledge to the practical problems of human existence is a notable example of the way in which the influence and activities of the Garden staff transcend the narrower limits of the Garden itself.

The continued interest and liberality of Mrs. Mortimer J. Fox has enabled Dr. Stout to continue experimental investigation of the genus *Lilium*, with large additions to the collection of hardy species, over 5,000 bulbs having been planted during the year.

Dr. P. A. Rydberg has continued his systematic studies of plants of the Rose and Pea families. The publication of a second edition of his Flora of the Rocky Mountains and Adjacent Plains, a volume of 1144 pages, in the early part of the year is an indication of the increasing demand for this valuable work.

Dr. Fred J. Seaver, in addition to his work as curator of the fungi, has given considerable attention to the study of the fungus flora of Porto Rico and the Virgin Islands and is preparing a systematic treatment of this group of plants for the Botany of these islands, to the publication of the first parts of which reference has already been made. He has also, nearly ready for the press, an illustrated descriptive work on the operculate cup fungi of North America, which will be an important contribution to our knowledge of these plants as well as an effective stimulus to their further study.

An investigation of the Hemlock Grove is in progress, in charge of a committee consisting of Mr. Moore, Professor Richards, Dr. Gleason, and Dr. Stout, in coöperation with the Yale Forest School, the New York State College of Forestry at Syracuse, and the Department of Forestry of Cornell University. The work thus far has consisted chiefly of the collection of data as to evaporation, solar radiation, precipitation, and maximum and minimum temperatures of the air and of the soil at six and eighteen inches depth. These observations will be compared with similar data obtained in stands of hemlock at New Haven, Ithaca, and at Cranberry Lake, in the Adirondacks.

Under direction by Dr. Murrill, our system of public instruction and information has been continued and expanded, aided by the income of the Darius Ogden Mills Fund. More public lectures have been delivered than in any previous year, through the aid of income from the Francis Lynde Stetson Fund, and there has been an increased demand for docentry service. Greater publicity has been given to the work of the institution through newspaper notices of special features and abstracts of lectures. All members of the staff have participated in this educational work, and in giving information by letters to hundreds of correspondents. Weekly radio talks on gardening topics, by staff members, with special reference to our plant collections, were broadcast through station WEAF, of the American Telephone and Telegraph Company, from April to September.

New construction work, directed by Mr. Corbett and by Mr. Finley, made possible by the use of part of the income of the Sage Fund, has been continued in the southern part of the reservation, including extension of the path-system, grading and the construction of about 600 feet of boundary wall and fence along Pelham Avenue, and of about 500 feet of the foundation for more of this wall and fence. Some preliminary work has been accomplished in developing the valley in the southeastern part of the grounds, for-

merly occupied by the long lake, into an extensive Rhododendron glade.

The Park Department has kept the Garden driveways in repair, as authorized by our charter, and has also completed the new road running northeasterly from the Rose Garden which has been under construction for several years. We are grateful to Commissioner Hennessy for valued advice and coöperation in matters of maintenance and construction. A liberal city appropriation for repairs and replacements was included, at his suggestion, in our budget estimates for 1924, and granted by the Board of Estimate and Apportionment.

The serial publications of the Garden have been continued, including our *Bulletin*, No. 43; twelve numbers of our monthly *Journal;* four numbers of *Mycologia;* three parts of *Addisonia*, completing the eighth volume; two parts of *North American Flora* and fourteen numbers of *Contributions*. The publications were aided by the income of the David Lydig Fund and of the Addison Brown Fund.

Our educational and scientific work and the increase of our collections of plants, books, and specimens, were largely accomplished during the year by contributions of money from 144 members and friends of the Garden, aggregating $16,935.03, as follows:

Dr. Robert Abbe	$ 25.00
Mr. Fritz Achelis	100.00
Mr. Edward D. Adams	500.00
Mrs. O. P. Amend	25.00
Anonymous	150.00
Anonymous	150.00
Mrs. George A. Archer	15.00
Mr. Vincent Astor	100.00
Mrs. E. S. Auchincloss	5.00
Mrs. Hugh D. Auchincloss	50.00
Mr. John W. Auchincloss	25.00
Mrs. Robert Bacon	100.00
Mr. Henry de Forest Baldwin	100.00
Mrs. A. Frederick Behre	10.00
Mrs. Robert C. Black	25.00

Mr. George Blumenthal	50.00
Mr. George S. Brewster	250.00
Mrs. Willard C. Brinton	10.00
Mr. John I. D. Bristol	10.00
Dr. N. L. Britton	250.00
Mrs. Helen C. Brown	25.00
Mr. Henry L. Calman	25.00
Mrs. Andrew Carnegie	250.00
Mrs. Percy Chubb	25.00
Mr. C. A. Coffin	50.00
Miss Clarkson Cowl	50.00
Mrs. Jonathan H. Crane	25.00
Mr. Paul D. Cravath	25.00
Mr. James W. Cromwell	250.00
Mrs. E. B. Currier	25.00
Mr. J. Clarence Davies	25.00
Mr. Henry W. de Forest	500.00
Mr. Wm. Adams Delano	25.00
Mr. Moreau Delano	25.00
Mrs. Charles D. Dickey	50.00
Mr. Cleveland H. Dodge	100.00
Miss Ethel DuBois	25.00
Mrs. Matthew B. DuBois	25.00
Mrs. Coleman du Pont	25.00
Mr. John E. Dwight	10.00
Mr. Thomas C. Edmonds	10.00
Mr. S. M. Evans	10.00
Mr. Charles S. Fairchild	25.00
Mr. Samuel W. Fairchild	50.00
Mrs. Francis C. Farwell	5.00
Mr. William C. Ferguson	25.00
Mr. James B. Ford	250.00
Mr. Theo. Foulk	25.00
Mrs. Mortimer J. Fox	250.00
Mr. Childs Frick	100.00
Mr. R. L. Giffen	10.00
Mr. Daniel Guggenheim	1,000.00
Mr. Murry Guggenheim	500.00
Mrs. Harry L. Hamlin	10.00
Miss Elizabeth Stewart Hamilton	100.00
Mrs. Wm. Pierson Hamilton	25.00
Mr. J. Horace Harding	100.00
Mr. Edward S. Harkness	2,000.00
Mrs. Stephen V. Harkness	2,000.00
Mrs. E. H. Harriman	150.00
Miss Caroline C. Haynes	309.03
Mr. Rowland Hazard	10.00
Miss Anne Hinchman	25.00

Mr. Anton G. Hodenpyl	100.00
Mrs. Richard March Hoe	25.00
Mr. John S. Holbrook	25.00
Mr. Arthur M. Hunter	10.00
Mrs. Edward F. Hutton	100.00
Mr. Adrian Iselin	50.00
Mr. A. W. Jenkins	25.00
Mr. Walter Jennings	50.00
Mrs. John I. Kane	200.00
Mrs. Hamilton Fish Kean	10.00
Prof. James F. Kemp	100.00
Mrs. Gustav E. Kissel	50.00
Mrs. Charles Potter Kling	50.00
Mrs. Sarah H. Lancashire	5.00
Mr. Edward V. Z. Lane	100.00
Mr. Henry Goddard Leach	25.00
Mr. Adolph Lewisohn	100.00
Mrs. Francis G. Lloyd	50.00
Mr. Pierre Mali	50.00
Mr. William J. Matheson	100.00
Mrs. Rosalynde de L. Mayer	25.00
Mrs. James McLean	100.00
Mrs. Regina V. G. Millhiser	10.00
Mr. Ogden Mills	200.00
Mr. Ogden L. Mills	250.00
Mr. Barrington Moore	161.00
Miss Katharine T. Moore	25.00
Mr. J. P. Morgan	500.00
Mrs. J. P. Morgan, Jr.	25.00
Mrs. Pierpont Morgan	10.00
Dr. Lewis R. Morris	500.00
Mrs. S. Neustadt	25.00
Mr. E. E. Olcott	25.00
Mrs. William Church Osborn	25.00
Mr. Charles Lathrop Pack	50.00
Mrs. Wheeler H. Peckham	40.00
Mr. W. H. Perkins	100.00
Mrs. F. A. C. Perrine	50.00
Mr. G. A. Pfeiffer	100.00
Mr. Walter Pforzheimer	10.00
Mr. E. W. Poor	10.00
Mr. Abram S. Post	5.00
Mrs. Herbert Lee Pratt	25.00
Mrs. William Kelly Prentice	100.00
Mr. Charles F. Rand	50.00
Mr. Ogden Mills Reid	50.00
Mr. John J. Riker	100.00
Mr. William C. Rives	25.00

Mrs. John A. Roebling	100.00
Mrs. James Roosevelt	50.00
Mr. Mortimer L. Schiff	250.00
Miss Grace Scoville	25.00
Mrs. James A. Scrymser	500.00
Mr. A. R. Shattuck	100.00
Mrs. Finley J. Shepard	25.00
Mrs. Benson B. Sloan	50.00
Mrs. Samuel Sloan	50.00
Mrs. B. G. Spiegelberg	10.00
Mr. Edward H. Squibb	25.00
Mr. Edward R. Stettinius	50.00
Miss Ellen J. Stone	50.00
Mr. Charles Strauss	25.00
Mrs. Theron G. Strong	25.00
Mr. F. K. Sturgis	250.00
Mrs. James Sullivan	10.00
Miss Mary Taber	10.00
Mr. Charles G. Taylor	50.00
Mrs. Henry O. Taylor	200.00
Mrs. John T. Terry	100.00
Mrs. F. F. Thompson	100.00
Mr. Louis C. Tiffany	100.00
Mr. A. F. Troescher	25.00
Mr. Ludwig Vogelstein	25.00
Mr. Felix M. Warburg	50.00
Mr. Artemas Ward	100.00
Mr. H. H. Westinghouse	50.00
Dr. Wm. E. Wheelock	10.00
Mr. W. P. Willis	25.00
Mr. Grenville L. Winthrop	50.00
Miss Julia Wray	100.00
Mrs. A. Murray Young	25.00
Total	$16.935.03

Contributions to Endowment, aggregating $7,375, were received from 24 members and credited to our Science and Education Fund, as follows:

Mr. George T. Bowdoin	$ 100
Mrs. Benjamin Brewster	20
Mrs. W. Bayard Cutting	100
Mr. Charles Deering	500
Mr. Arthur S. Fairchild	100
Mrs. John Gribbel	20
Miss Elizabeth Stewart Hamilton	25
Dr. Louis Hauswirth	10

Miss Caroline C. Haynes	25
Mr. W. L. Hernstadt	10
Mr. Arthur M. Hunter	25
Dr. & Mrs. Frederic S. Lee	5,000
Mr. M. C. Lefferts	25
Mr. John Markle	25
Mrs. Acosta Nichols	100
Mr. George Notman	50
Mrs. Wheeler H. Peckham	25
Mrs. George W. Perkins	1,000
Mr. Samuel W. Reyburn	25
Mrs. W. Emlen Roosevelt	50
Miss Mary Taber	10
Mrs. John B. Trevor	100
Mr. Allen Wardwell	25
Mr. Charles Zoller	5
Total	$7,375

The institution has now, after about 27 years' effort, reached a stage of development in which it takes rank as one of the largest and most important botanical gardens of the world and by far the most important in America. Its reservation of land in Bronx Park, nearly four hundred acres, is unequalled in natural beauty and in variety of soil; it is valued at not less than $15,000,000. Its system of driveways and paths has been about nine-tenths constructed as planned; nearly all necessary grading and drainage has been accomplished and water-supply provided. Over 15,000 species and varieties of plants are under cultivation in the grounds and greenhouses and the special horticultural collections have attained great development. The museum building contains numerous collections of unsurpassed scientific and economic value. Our educational and informational work through public lectures, docentry, publications, correspondence, and labelled collections is of vast importance. Our library is one of the most extensive and complete accumulations of botanical and horticultural literature in existence. Our investigations have already added much to human knowledge. Available funds for expenditure are insufficient to enable us as yet to take full advantage of this great insti-

tutional development for the public service. Larger provision is required for the maintenance of grounds, buildings and collections; for the installation and upkeep of additional plantations, both decorative and educational; for the completion of buildings and for the development of our unsurpassed opportunities for scientific investigation and teaching.

The generous endowments that public-spirited and far-sighted citizens of New York have provided for other institutions give us ground for confidence that the financial needs of The New York Botanical Garden will eventually be recognized and met. The Garden exists for public service, for the enjoyment of the people, and for the advancement and diffusion of knowledge of the plant world, on which mankind is dependent. The renowned Royal Botanic Gardens at Kew, with several centuries behind them, have exerted a great influence in the development of the British Empire. New York, the financial leader of the world, will see to it that its own somewhat similar institution, now less than thirty years old, will not lack the means with which to fulfill its destiny.

I append reports giving details of maintenance, development and instruction by Dr. Small, Head Curator, by Dr. Murrill, Supervisor of Public Instruction, by Mr. Boynton, Head Gardener; by Dr. Stout, Director of the Laboratories; by Dr. Barnhart, Bibliographer; by Miss Harlow, Librarian; by Mr. Corbett, Superintendent of Buildings and Grounds; by Dr. Hollick, Paleobotanist; by Mrs. Britton, Honorary Curator of Mosses; by Dr. Rusby, Honorary Curator of the Economic Collection; by Dr. Denslow, Honorary Custodian of the Local Herbarium; and a schedule of expenditures by Mr. Groesbeck, Bookkeeper.

Respectfully submitted,

N. L. BRITTON,

Secretary and Director-in-Chief

REPORT OF THE HEAD CURATOR OF MUSEUMS AND HERBARIUM

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit herewith my report as Head Curator of the Museums and Herbarium, for the calendar year 1923.

The research collections and public exhibits under my supervision were conserved and developed as in the preceding years, and were augmented by specimens as indicated in the accession lists printed in the *Journal* from time to time. Summarized, the accessions may be indicated as follows:

By gift and purchase	8,050
By exchange	9,074
By exploration	10,992

The total items accessioned are therefore 28,116.

About 1,200 duplicate specimens were sent to other herbaria as exchanges.

Museums

The equipment of the public museums remained as in the preceding year. Miscellaneous specimens were interpolated in the exhibits. The (*a*) Synoptic Collection; (*b*) The Local Flora; (*c*) the Microscope Exhibit; and (*d*) The Plant Picture Exhibit were maintained, but little changed from the condition of the preceding year. The Fossil Plant Museum was increased by specimens from various parts of the globe. The bulk of the specimens throughout the museums came from the collections made on trips of exploration and through the personal efforts of Dr. H. H. Rusby. See his report.

Herbaria

Specimens from many parts of the world were received during the year. Although some material came from Australia, Asia, Africa, and Europe, the great bulk represents the flora of (1) northern South America (Colombia, British Guiana, Venezuela); (2) North America, including

the (*a*) West Indies (Cuba, Porto Rico, and Virgin Islands), (*b*) Central America (Panama, Salvador), (*c*) Mexico, (*d*) the United States, and (*e*) Canada; and (3) the Galapagos Islands. Especial attention was devoted to the local flora herbarium. The accessions, about fifteen hundred specimens, were mainly native plants, collected by members of the Torrey Botanical Club on field excursions, and a large series of naturalized exotics, mostly European, from the greater New York, collected and presented by Mrs. Mary Holsoff. The detailed geographical origin of the specimens received during the year is given in the accession lists of the *Journal*.

About 31,400 sheets of mounting paper were incorporated in the various herbaria. This accumulation represents the addition of about 46,000 flat specimens to the herbarium. Bulky specimens were, as usual, disposed in cardboard boxes and incorporated in the seed and fruit collection. Specimens received for the Columbia University herbarium were incorporated in that collection.

In addition to incorporating novelties, considerable attention was devoted to conserving and repairing specimens already in the various collections.

The herbarium equipment was augmented by twelve herbarium cases and two book cases.

Assistance and Investigations

In addition to the mechanical tasks connected with the care and development of the collections, the curators have accomplished some work of a technical scientific character.

Dr. P. A. Rydberg, Curator, has been in charge of the collections of flowering plants. During the earlier part of the year he spent most of the time that was not occupied by mere routine work in sorting unmounted material accumulated during 1922, preparing a part for mounting and the rest for duplicates to be sent out as exchanges. The larger collections of duplicates have been sent to the University of California, California Academy of Sciences, Stanford

University, Pomona College, University of Minnesota, as well as to the herbaria of Paris and Geneva. During the summer months, some available time was devoted in taxonomic work, for *North American Flora*, especially on the genus *Astragalus* and its allies, and the last two months in moving and expanding the main herbarium into the new cases. The following scientific papers have appeared during the year: Notes on Rosaceae—XIV, containing the Roses of the Prairies and Plains; Notes on Fabaceae—I–III, containing notes on the genus *Homalobus*, all in the *Bulletin* of the Torrey Club, and North American Genera of Fabaceae—I, in *The American Journal of Botany*. In January there was issued the second edition of his Flora of the Rocky Mountains and Adjacent Plains, printed during the later part of 1922.

Dr. Marshall A. Howe, Curator up to December first, subsequently Assistant Director, continued in charge of the collections of algae and hepaticae, and acted as Assistant Director for nearly four months. Good progress was made in the work of incorporating the F. S. Collins collection of algae into the regular herbarium. Dr. Howe has, for the sixth year, given much of his time to the exhibition border of choice varieties of dahlias, and has given several lectures on dahlias in New York City and vicinity, including one that was broadcast by the American Telephone and Telegraph Company (WEAF) and was published, with the addition of illustrations, in the September number of the Garden *Journal*. His principal publication for the year was the systematic treatment of the Ricciaceae in Vol. 14 of *North American Flora* and (with Miss Caroline Coventry Haynes) of the Sphaerocarpales in the same volume. He continued to act as secretary of the Torrey Botanical Club and associate editor of its publications, as a member of the Council of the New York Academy of Sciences, and as a member of the Board of Control of Botanical Abstracts. He has given eight lectures in the Saturday and Sunday afternoon courses at the Garden.

Dr. Fred J. Seaver, Curator, continued in charge of the collections of ascomycetes and lower fungi—Dr. Murrill caring for the higher forms. The time from January 20 to April 9 was spent in Porto Rico and the Virgin Islands, as the guest of the Porto Rican government, the exploration involved having been made at the request of the insular government. The object of the expedition was to collect and study the fungi occurring in the islands preparatory to listing these in the Botany of Porto Rico and the Virgin Islands which is being prepared by yourself and Mr. Wilson for the New York Academy of Sciences. More than a thousand collection numbers of fungi were brought back for study. The greater part of the remainder of the year was spent in working over these collections and several preliminary papers relating to the work are now in press. A number of exchanges of fungi with other institutions were also made. Two lectures were given and some time devoted, as usual, to the work on destructive insects in the Garden reservation.

Mr. Percy Wilson, Associate Curator, during the first quarter of the year devoted some time to the determination and distribution of West Indian specimens and to docentry. The remainder of the time was devoted to the preparation of manuscript and the reading of proof for the "Botany of Porto Rico and the Virgin Islands" in coöperation with yourself. Later in the year his attention was given to collections in the field and to the care of some of the plantations of the Garden and of the collections in the Propagating Houses.

Mr. James A. Crawford, Associate Curator up to the end of October (then resigned), devoted his time to helping Dr. Gleason with his work on the large collections of specimens from northern South America, to editorial work, and to the listing of duplicate books in the library.

Mrs. Palmyre deC. Mitchell, Associate Curator since November first, devoted her time to library work and to aiding Dr. Rydberg in caring for the herbarium of flowering plants.

Dr. H. H. Rusby, Honorary Curator of the Economic Collections, continued to develop the collections of the Economic Museum. See his report.

Mrs. N. L. Britton, Honorary Curator of Mosses, continued to develop the moss herbarium. See her report.

Dr. Arthur Hollick, Paleobotanist, continued the development of the collections of fossil plants. See his report.

Dr. H. M. Denslow, Honorary Custodian of the Local Herbarium, devoted his time at the Garden to the development of the local flora herbarium. See his report.

The writer, aside from curatorial routine and details, continued to devote attention to studies in the flora and floristics of the southeastern United States, to the securing of miscellaneous desiderata for the herbarium, chiefly through correspondence, and to studies in special groups of plants, such as spider-lilies, flags, zamias, prickly-pears, and palms. Miscellaneous manuscripts for *Addisonia* and the *Journal* were prepared. Several articles, accounts of species, histories of native palms, and narratives of exploration, were printed. Explorations in the Florida mainland and the Florida Keys were continued. Accounts of the results of the field work have been embodied in articles that will appear in the *Journal*. Many valuable specimens for the museums, the herbarium, and the conservatories were secured while in the field in South Carolina and Florida. The specimens just referred to represent material secured through the coöperation of Mr. Charles Deering in whose reservations in southern Florida we are making plantings of rare and critical species for study. The largest recent addition to the botanical facilities of the Deering reservations is a century-plant garden, while the installation of an iris garden, to contain a large portion of the American iris material we are now assembling at the Garden and in the Miami region is contemplated for next year.

Respectfully submitted,

JOHN K. SMALL,

Head Curator of the Museums and Herbarium

REPORT OF THE SUPERVISOR OF PUBLIC INSTRUCTION

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1923.

Lectures

Lectures on botanical and horticultural subjects were given every week in the year. Sixty-nine illustrated public lectures were given in the Museum Building on Saturday and Sunday afternoons from April 1 to November 25 inclusive, the titles of which were published in the *Journal*. I substituted for Dr. Gleason on April 22 and October 27, and for Miss Lee on May 19; while Mr. Arthur Herrington filled Mr. Pyle's appointment on June 17. The attendance reached 200 on May 20, August 4, August 11, September 1, and September 23; and 300 on September 22, when Dr. Howe lectured on "Dahlias and Their Culture." The average for the entire series of 69 lectures was about 119; or 127 for the 34 Saturday lectures and 110 for the 35 Sunday lectures.

During the winter, public lectures and demonstrations were given in the central display greenhouse at Conservatory Range 2. The attendance at these lectures on Sunday afternoons during January and February averaged about 20, and during March about 40, the largest number being present at a talk given by Mr. Wilson, March 18, on "Shrubs in Winter." The average for the five greenhouse lectures on Saturday afternoons in December was about 27.

Most of the above lectures were reported in *The New York Times* and *Bronx Home News*, abstracts being sent to these papers in advance.

Lectures to Girl Scouts

A series of four illustrated lectures was given by me in early spring to the Girl Scouts of the Bronx in the Museum Building, as reported in the *Journal*. The subjects were: "Shade Trees," "Wild Flowers," "Edible and Poisonous Fungi," and "Flowering Plants in Cultivation."

School Lectures and Demonstrations

The biology pupils of the Morris High School and the Evander Childs High School came to the Garden with their teachers, as is their custom in January and June, to see the living plants and museum collections and to hear a lecture on forestry. Most of the members of the Garden Staff assisted with the demonstrations on these occasions. On June 18, 19, and 20, the attendance of biology pupils from the two schools mentioned reached a total of 1881.

Docentry

A great many special appointments were made with visiting classes from other schools and colleges in and near New York City, such as Columbia University, Rutgers College, Hunter College, high schools in Manhattan, Brooklyn, Newark, etc., and special schools like the summer school at Cold Spring Harbor and the school of floriculture conducted by Max Schling. Julia Richmond High School was represented by 400 pupils on June 1. Many parties of Girl Scouts and Mount St. Ursula biology pupils also visited the grounds at various times during the year.

Meetings

Since the burning of the mansion, we have been somewhat handicapped by the lack of a suitable room for club meetings. The Stamford Garden Club held an outdoor meeting here on May 22, with 35 members present. On the afternoon of October 2, the City Gardens Club, which promotes the development of gardens in the municipality, met on the second floor of the Museum Building in one of the wings. Twenty members were present, Miss Frances Peters presiding. On October 18, the New York Bird and Tree Club held an out-door meeting here, with a formal meeting in the Museum Building after a basket luncheon.

Floral Exhibitions

Special exhibitions of flowers were held in the Museum Building on the dates given below. Fine displays of flowers

on the grounds at various seasons also attracted much attention.

May 12, 13. Exhibition of Spring Flowers.
August 3–5. Exhibition of Gladioli.
September 21–23. Exhibition of Dahlias.

Personal Investigations

The work of my department has expanded considerably during the year, especially as regards lectures, visitors, and the giving out of information by correspondence and through the public press. Editorial and curatorial work, with the determination of an unusual number of mycological specimens, has been continued as formerly. My researches during the past year were confined chiefly to studies in the field. A month was spent in exploration in Florida, and all of my vacation was devoted to collecting trips to Virginia, Woodstock, Interstate Park, and Lake Placid; accounts of which appeared in the *Journal* and in *Mycologia*. Several taxonomic articles were prepared for *Mycologia* and a new series of lectures for the museum course.

Respectfully submitted,
W. A. MURRILL,
Supervisor of Public Instruction

REPORT OF THE HEAD GARDENER

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to present herewith my report for the year 1923.

Horticultural Operations

The gardening force under the direction of Messrs. John Finley and H. W. Becker, Foremen Gardeners, consisted of 27 gardeners, an average of about 14 laborers and 1 apprentice gardener. Outdoor operations under Mr. Finley's supervision included an increased amount of cultivation to conserve moisture, the season being the driest in many years. Some 40 shrubs were transferred from nurseries to

the Fruticetum, 28 trees of 17 species from nurseries to the Arboretum, 25 trees of 9 species from nurseries to the Pinetum, 10 trees from nurseries to roads and paths, 38 species from nurseries to Herbaceous Grounds and 25 plants from nurseries to Morphological Garden. About 150 plants in 35 varieties were added to the Lilac Garden, 200 plants of 100 varieties of climbing roses were planted in the new area at the Rose Garden under the supervision of Mr. John Baardse, representing Bobbink and Atkins of Rutherford, N. J., and 35 plants, representing 20 species of wild roses, were planted on the hill west of the Rose Garden.

Two more Iris beds were opened up and planted, one more dahlia bed made and a portion added on to the east bed, 100 feet in all, 100 square feet were added to the Chrysanthemum bed to accommodate 13 new varieties, 100 square feet to the west lily bed for collected bulbs of the Turk's-cap Lily from Staten Island; five new beds were opened in the Narcissus collection and 5000 square feet in the Conservatory Court to receive, with the 7 old beds, the 80,500 tulips given by the Dutch Bulb Growers' Association. 3000 square feet of ground was opened to duplicate the Rhododendron planting on the east front of Range No. 1, the Rhododendrons on the northeast bank of the lake were moved south to the corner of the hemlock forest and in their place were planted cornels and dockmackie collected in the grounds. 25 Retinisporas were planted at the Lilac Garden entrance and Arbor-vitae and Douglas Spruce at the Elevated Approach to replace tall shrubbery removed. The Rock Garden, under the direction of Dr. E. B. Southwick, was expanded by special construction work to include 4000 more plants, and additional space in the northern end was prepared and planted with a collection of local wild flowers.

Two beds were canceled in the Herbaceous Grounds and the whole collection there compressed and replanted, leaving open beds for new planting.

Greenhouse Operations

The greenhouse work, under Mr. Becker's direction, included the rearrangement of the collections in more attractive form, the increasing and propagation of the foliage plant collections and the renovation and propagation of the orchid collection.

The hardy waterlilies were taken up and placed temporarily in the tender-lily tank pending repairs on the hardy-lily tank.

At Conservatory Range No. 2, 1650 plants, including 300 chrysanthemums, 225 Cinerarias 287 Primulas, 100 Begonias, 184 Stocks, 156 Pelargoniums, 168 Fuchsias, 163 Hippeastrums, and 68 Hydrangeas were grown for exhibition in the Central Display House.

The new Chrysanthemum display, given by Elmer D. Smith & Co., Adrian, Michigan, consisted of 113 plants of 60 varieties, mostly new sorts originated by this company.

At the Propagating Houses many seedlings were raised for the herbaceous and woody collections, 50 varieties of annual flowering plants for the conservatory beds, and many greenhouse plants renovated and propagated before being sent back to the collections.

Planting was started from the Propagating Houses to the new nursery area.

Systematic Plantations

HERBACEOUS GROUNDS. The herbaceous collections comprise about 2913 species and varieties in the Herbaceous Grounds, nurseries, and flower gardens.

WOODY COLLECTIONS. In the Fruticetum, Salicetum, Arboretum, Pinetum, and Viticetum are located about 3100 plants, representing 850 species in 95 genera.

CONSERVATORIES. Nearly 23,700 plants are now housed under glass, representing 9000 species and varieties disposed as follows: Range 1, 8597; Range 2, 9236; Propagating Houses, 5855; in Conservatory Court tanks, 81 varieties, 275 plants, of waterlilies were shown. In

coöperation with private estates and institutions, Mr. Becker has greatly increased the foliage plant collections, especially the Begonias, Crotons, Dracaenas, Marantas, and others of interest to the amateur as house plants, school room plants, or plants for small greenhouses. The Begonia collection now contains nearly 500 plants, including 24 varieties of *Begonia Rex* and 51 varieties of other species.

There are now in our collections, 113 Crotons in 43 varieties; 2137 plants, 390 kinds, of other foliage plants; 3458 succulents, 486 aroids, and 3500 coolhouse plants of 438 kinds.

Miscellaneous Collections

Rose Garden. About 500 hybrid tea roses were planted in the spring and 200 plants of climbing roses in 100 varieties were received in the autumn from Messrs. Bobbink and Atkins of Rutherford, N. J., the collection now showing about 4500 plants given by that firm. Mrs. Mortimer J. Fox has presented the Garden with plants of Kazanlik, a rose used for making attar, and York and Lancaster, a rare old red and white Damask rose.

Dahlia Garden. 450 varieties represented by 853 plants were shown in the dahlia borders, under the direction of Dr. Marshall A. Howe.

Iris Garden. The test garden of the American Iris Society now contains 1212 varieties and numbers 2930 plants, 287 being added this year.

Tulip Display. Through the coöperation of Mr. H. J. Arentshorst, the Dutch Bulb Growers' Association, M. Van der Koog, Sec'y, shipped us 16 cases of tulips for our 1924 display. This gift of 80,500 bulbs was planted as follows: Early Singles, 40 varieties, Early Double, 10 varieties, Cottage, 12 varieties, and Breeders, 20 varieties, in the Conservatory Court; Darwin, 43,000 bulbs, 72 varieties, in the Horticultural Grounds and around the Museum approach fountain.

NARCISSUS COLLECTION. About 5000 bulbs in 5 varieties were replanted in the Horticultural Grounds, making, with 1000 King Alfred in place there, 6000 plants in the Narcissus planting.

PEONY COLLECTION. This display contains 340 plants in 126 varieties.

PHLOX COLLECTION. The perennial phlox collection contains 25 varieties, 220 plants.

VARIEGATED PLANT COLLECTION. 62 kinds of variegated plants 500 in number, were shown.

CANNA COLLECTION. 1500 plants of 60 varieties were displayed in the Canna beds this year.

GLADIOLUS COLLECTION. 200 varieties, represented by 13,000 plants, were displayed in the Horticultural Grounds.

HARDY CHRYSANTHEMUM COLLECTION. 13 new varieties, 100 plants, were added from Chas. H. Totty, through the interest of the Garden Club of America, making this display 680 plants in 68 varieties.

LILY GARDEN. 620 bulbs were planted in the lily beds, including 300 *Lilium superbum* collected on Staten Island by Dr. N. L. Britton and Dr. A. B. Stout; other varieties and continued replacements, including Japanese bulbs still to come, being given by Mrs. Mortimer J. Fox.

LILAC GARDEN. 150 plants, in 35 varieties, were added, this collection now numbering 560 plants in 185 varieties.

FERN GARDEN. Collections by Dr. E. B. Southwick and plants sent by fern students have added about 800 plants to this collection, making nearly 10,000 plants placed here since it was rebuilt.

ROCK GARDEN. Under the direction of Dr. E. B. Southwick the Rock Garden planting has again nearly redoubled. More than 4000 plants were placed, including 100 alpines given by Mr. Clarence Lown of Poughkeepsie N. Y., small bulbous plants given by Mrs. W. H. Peckham, and many kinds propagated by Dr. Southwick. Native wild flowers collected by Dr. and Mrs. Britton, Mr. Rossiter, and Dr. Southwick were added to the north end.

Labeling, Recording, and Herbarium

Under the direction of Mr. John Hartling, Head Gardener's Assistant, with one label boy, a total of 4133 labels have been made and placed, including 480 for Dahlias, 645 for Conservatories, 618 for Horticultural Collections, 190 for Herbaceous Grounds, 92 for Arboretum, 295 for Morphological and Economic Gardens. About 1075 labels were made and placed on the Pinetum and roadside trees through the assistance of Mr. Percy Wilson and Mr. A. S. Foster. Triangle family signs to the number of 92 were repainted and relettered and 7 house signs and 49 school lecture signs were made. 4000 pot labels were repainted and 3000 wooden labels cut and painted.

Accession numbers 51,367 to 52,459 have been recorded, making a total of 1092 accessions for the year. 125 packets of seed, 49 by gift, 29 by purchase, 35 by exchange, and 12 by collection were received. 83,120 bulbs were received, and 8896 plants, of which 1477 were by gift, 2267 by purchase, 2218 by collection, 462 by exchange and 1672 from seed. 200 specimens were added to the herbarium of cultivated plants and much material for class work in schools and colleges has been collected throughout the year.

Lectures

I have delivered seven lectures in the regular courses, three in the winter courses, have given twenty-two talks on garden topics from Radio Station WEAF, (American Telephone and Telegraph Co.) and have demonstrated our collections of shrubs and evergreens to students of horticulture from Columbia University.

Respectfully submitted,

KENNETH R. BOYNTON,

Head Gardener

REPORT OF THE DIRECTOR OF THE LABORATORIES

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to present the following report for the year 1923.

The first five and one-half months of this calendar year were spent in southern California, completing a nine months' leave of absence from the Garden. During this period there was opportunity to study problems of sterility in several important fruit crops. A study of the viability of the pollen of the date palm was made in coöperation with Dr. Walter T. Swingle of the Bureau of Plant Industry, and a special investigation was made of the flower mechanism of avocados with reference to pollination and fruit production.

During my absence from the Garden, Miss Hester M. Rusk very ably continued the main lines of experimental work already under way and performed the routine duties incident to the laboratories and to the keeping of metero-logical records. Mrs. Jean Kerr has continued during the year as a voluntary and unpaid assistant.

Investigations

As in recent years, the research under my charge has been almost entirely devoted to studies (1) of bud variation and (2) of phenomena of sterility and fertility.

In *Coleus*, *Pelargonium*, and *Abutilon*, several new bud variations have appeared, involving leaf shape or variegation. These are being studied along with other bud sports previously obtained as to constancy in vegetative propagation and heredity in seed progenies. Special attention is being paid to the infectious type of variegation.

Studies of sterility and fertility continue as my main line of research. The effort is to become acquainted with all the different types of sterility, to determine their nature and their behavior in vegetative propagation and in seed progenies, and most of all to understand their relation to seed and fruit production. The numerous species of *Lilium* being grown, and the cultures of sweet potato, *Hemerocallis*, *Brassica*, *Pelargonium*, and *Lythrum* have given interesting and valuable results. Further green-house facilities with equipment for controlling light and

humidity are greatly to be desired in the studies of the blooming habits of plants.

Two weeks in August were spent at Presque Isle, Maine, continuing studies of sterility in potatoes in coöperation with Professor William Stuart and Dr. C. F. Clark of the Bureau of Plant Industry. During this time the study of seedling varieties was much extended, and a study of several species and of certain hybrids was made.

As the season for the blooming of grapes was past when I returned to New York last June, the usual spring trip to Geneva for work with grapes was not made. The seedlings obtained in the breeding work during the last few years are being grown at Geneva and will soon yield new material for study and for use in further breeding. There is also a wealth of material available at Geneva for an investigation of sterility and fertility in such important fruit crops as the apples and the pears. Such studies promise results of special scientific and economic interest and value. I request permission and support in continuing such studies in coöperation with the Department of Horticulture at the Geneva Experiment Station and elsewhere as opportunity may arise.

The rather extensive studies with the genus *Lilium* are progressing very satisfactorily along the lines already definitely mapped out and reported to you in detail.* Bulbs and seeds of more species are being obtained by purchase and by gifts from correspondents. Many seedlings are being grown, some of them hybrids, from our own breeding. In a few years these will greatly enlarge our collections for experimental study and for display plantings. Mrs. Mortimer J. Fox has liberally continued her support and coöperation. The construction of four new cold frames, from funds supplied by her, has furnished facilities much needed for the proper care of the seedlings. A popular account of sterility of lilies, with directions how to circumvent incompatibilities in getting seed has been pub-

* Jour. N. Y. Bot. Gard. 23: 155–158. 1922.

lished and this was reprinted in *The Gardeners' Chronicle* in England. Other popular accounts of the observations and results of our experiments in the breeding, propagation, and culture of lilies will be presented as rapidly as the results warrant. Mrs. Fox, Miss Rusk, and I coöperated in preparing the number of *Addisonia* devoted entirely to lilies, which appeared too late to be mentioned in my report for 1922.

Students and Scholars

The students and investigators formally registered during the year for research at the Garden are as follows:

Cover, Louise A.,	Plant breeding.
Dalbey, Nora E.,	Cytology of Head Smut of Sorghum.
Foster, Adriance S.,	Dendrology.
Gaiser, Lulu O.,	Cytology.
Hylander, Clarence J.,	Algae, the Cladophoraceae.
Kozlowska, Aniela,	Ecology.
Rosin, Albert A.,	Plant breeding.

Respectfully submitted,

A. B. STOUT,
Director of the Laboratories

REPORT OF THE BIBLIOGRAPHER

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1923.

By far the largest addition ever made to the library has occurred during this year. By the recent consolidation of several botanical institutions in Geneva, Switzerland, the "Conservatoire botanique" of the University secured an immense number of duplicates, and these were purchased as a whole for our library. They arrived during the summer; most of them have been unpacked and inspected.

The entire collection comprises about five thousand bound volumes, besides thousands of unbound volumes and

pamphlets. It is noteworthy for the number of fine folios and beautifully bound volumes, and even among the unbound ones and pamphlets are many rarities. The number of works not previously in our collection is considerable, but even more important, perhaps, is the acquisition of fine copies of hundreds of volumes previously represented only in the deposit of Columbia University and subject to withdrawal at any time. Of course such withdrawal was not anticipated, but had it occurred prior to this purchase all of the work at the Garden would have been hampered seriously.

Of course it will be a long time before all of the additions from this source can be incorporated into the library; a beginning has been made, however, and the accessions during the present year are included in the statistics presented in the report of the Librarian.

Work on this Geneva purchase hampered the editorial work on *North American Flora* during the latter half of the year. Volume 14, part 1, was issued in January; volume 24, part 3, in July; four or five parts are standing in type, and it is hoped that these may soon appear in quick succession. Three numbers of volume 8 of *Addisonia* have been published; the concluding number has been delayed, but should appear in January.

Respectfully submitted,
JOHN HENDLEY BARNHART,
Bibliographer

REPORT OF THE LIBRARIAN

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1923.

A recent census of the library shows a total of 32,311 bound volumes, an increase of approximately 1300 over the census of 1922. Of these there were acquired by gift 76, by exchange or deposit 94, and by purchase 688. Of the last mentioned the greater portion were included in the

books purchased from the Geneva Botanical Garden the past summer. (See report of Bibliographer). The principal accessions have been listed as heretofore in the *Journal*. The most noteworthy gift was that of a large number of volumes of the *American Journal of Science*, making our set now practically complete. These were presented by Mr. K. K. Mackenzie. During the year 54 volumes have been returned to the American Museum of Natural History.

There have been bound 516 volumes belonging to the Garden and 32 belonging to Columbia University.

Three new stacks have been installed in the laboratory. These will afford room for a considerable portion of the smaller books of the Geneva collection.

There have been added to the Catalogue 1442 typewritten cards and 2068 of those issued by the Torrey Botanical Club.

Lack of full-time assistance requires that much of the Librarian's time be spent in clerical work. If rapid progress in accessioning the newly acquired books from Geneva is to be made it seems imperative that additional help should be afforded.

The following omissions and additions should be made to the list of serials which was appended to the report of the Librarian for 1921 (*Bulletin* **12**: 41–61, 139).

Omit the following:

Irish Gardening. Dublin, Ireland.
La Plata. Museo de la Plata, La Plata, Argentina. *Revista.*
†Monatsschrift für Kakteenkunde, Neudamm, Germany.
Upsala. Regia Societas Scientiarum Upsaliensis, Upsala, Sweden. *Nova Acta.*

Add the following:

* American Journal of Science, New Haven, Conn.
Bulletin de Vulgarisation des Sciences Naturelles, Auch, France.
Bulletin Joseph Pâquet, Nice, France.
Canada. Biological Board of Canada, Toronto, Canada. *Contributions to Canadian Biology.*
Gothenburg Botanic Garden, Gothenburg, Sweden. *Seed Lists.*
University of Minnesota, Minneapolis, Minn. *Minnesota Studies in Plant Science.*

Natural History Society of Moravska Ostrava, Czecoslovakia. *Ročník.*
Nature Magazine, Washington, D. C.
Petrograd. Botanical Garden of the Russian Republic, Petrograd, Russia. *Bulletin, Notulae Systematicae.*
Schlesische Gesellschaft für vaterländische Kultur, Breslau, Germany. *Jahresbericht.*
Sociedad Argentina de Ciencias Naturales, Buenos Aires, Arg. *Physis.*
Societas Botanicorum Poloniae, Warszawa, Poland. *Acta.*
* Zeitschrift für Sukkulentenkunde, Berlin, Germany.

Respectfully submitted,
SARAH H. HARLOW,
Librarian

REPORT OF THE SUPERINTENDENT OF BUILDINGS AND GROUNDS

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1923.

Regulating and Grading

A great deal of grading was accomplished during the past year. The extreme southeastern corner of the Garden south of the large lake has been partly graded and the old quarry at the white pine plantation near the Iris Garden Entrance was graded and sown with grass seed. The Rose Garden north of the new road was regulated, graded, and planted with climbing roses.

As in previous years, contractors working in the vicinity of the Garden who were seeking to dispose of soil taken from excavations, carted about 3500 yeards of soil into the Garden at their own expense. Approximately 200 yards of this was good top soil and we placed it along the traffic road near Conservatory Range 1. In order to fill the bottom of the valley of the Long Lake, about 3300 yards of the above-mentioned soil were dumped on its eastern side near the outlet; this lake is now drained to a low flow level. Some years ago a contractor was permitted to bring blasted stone into the Garden and leave it at the southern end of the large lake; nearly 250 yards of this stone were used for building paths and fences along Pelham Parkway.

Drainage

In order to drain the Long Lake and hold the flow-line when filled, we built a culvert 20 feet long, one catch-basin, and installed 12 feet of 14-inch tile pipe. On the northern side of the new road at the Rose Garden, we put in 460 feet of 3-inch tile drain pipe and a catch-basin. Three culverts 20 feet long were installed in the lilac collection near the Mansion Approach Entrance and one culvert of the same size was built on the western side of the Bronx River near the picnic grounds.

Water Supply

All the hot and cold water pipes were replaced with new ones by our plumber at Conservatory Range 1. The badly rusted old pipe had been leaking constantly throughout the range. Other important repairs were made to the water system in the Museum Building, the Propagating Houses and Conservatory Range 2, as well as in the comfort stations and drinking fountains throughout the Garden.

Paths

A 10-foot path 300 feet long was completed near the iris collection in the southern part of the Garden bounding the western side of the picnic grounds. The path from the gate of these grounds was extended north for a distance of 220 feet and is now ready to be paved. The border path was extended eastward 200 feet and a culvert placed under it. At the Mansion Approach Entrance at Pelham Parkway, a 10-foot path 140 feet long was completed and a culvert installed beneath it. A 10-foot path 543 feet long, one half of which is paved, has been built in the garden of climbing roses. Another 10-foot path 400 feet long was constructed at the southeastern corner of the Garden, one half of which has been paved. The regraded path leading from Power House 1 to the Elevated Railway Approach was paved and completed. All the paths in the northern section of the Garden were cleaned and resurfaced, and

those at the Iris Garden and around the terrace at Conservatory Range 1 were resurfaced and rolled.

Buildings

The walls of the typewriting room and part of those on the second floor in the west wing of the museum building were painted. Necessary repairs to the windows, doors, and cases were made by the carpenter, and to the steam and water systems by the plumber and steam engineers.

The sash bars of houses 4, 6, 7, 11, and 13 of Conservatory Range 1 were repaired and broken glass replaced. In House 1 the steam engineers replaced one set of radiators and the carpenters repaired the doors and window sash. In each of houses 4 and 13 two coils were replaced and all necessary repairs were made to the steam supply pipe and risers. Three lengths of 6-inch steam-pipe were renewed between Power House 1 and Conservatory Range 1. A 6-inch expansion joint was put in the supply line under House 4 and all the valves and slip joints were packed.

The exterior of houses 2, 4, 6, 8, 10, 12, and 14 of Conservatory Range 2 received two coats of paint. All the old snow-guards were replaced with new frames and wire, and broken glass was also replaced. The steam engineers repaired the water and steam systems wherever it was necessary.

Houses 5 and 6 of the Propagating House were painted and several sash bars were repaired. For the purpose of securing a better draft in order to burn the coal we are obliged to use, the chimney here was elevated ten feet. The gutters of the potting house were replaced as well as all broken glass. A new gutter was added to the stable, the roof repaired and all the stalls were refloored.

We were compelled to retube the five boilers in Power House 1; at Power House 2, boiler 6 was also retubed and five tubes were placed in boiler 7. This was done by contractors, but the repairs to the brickwork were the work of our own employes.

The storage house under the Elevated Railway Approach has been completed. A foundation 130 feet long, 12 inches wide and 3 feet deep was constructed, and over this foundation an 8-inch brick wall was built. Eight windows 3½ feet wide and six feet high were installed, as well as two pairs of doors ten feet square. A guard wire was placed outside the windows and the floor concreted.

On March 26 of this year, at ten forty in the forenoon, Jeremiah Moore called my attention to an unusual crackling noise on the roof of the Mansion. Upon immediate investigation I found the roof ablaze and then hurriedly telephoned the Fire Department. Forty-five minutes had elapsed before the engines arrived and the fire was not under control until half past three in the afternoon. The engines were operating until midnight. The two upper floors and attic were destroyed, but the stone and brick walls are still intact. The paintings and engravings, as well as the greater part of the collections on exhibition here by the Bronx Society of Arts and Sciences were rescued from the fire through the diligent efforts of park employes and the fire patrol, and nearly all furniture and other Garden property was saved.

Grounds

The hardy water-lily tank in the court of Conservatory Range 1 was emptied of all its contents and cleaned. About 250 yards of soil were removed from it, some of which has been spread over the lawns and the remainder stored for fertilizing purposes.

The carpenter repaired the cedar fences at the Woodlawn Road Approach and those along the Bronx River and the mansion road. All the one- and two-rail iron fences upon the grounds were repaired. Along Pelham Parkway west of the Bronx River a foundation 344 feet long, 20 inches high and 3 feet deep was built for a fence. Upon 210 feet of this foundation a rubblestone wall 18 inches high was erected. A six-foot iron fence 550 feet long and fifteen stone piers 8 feet high were constructed along Pelham

Parkway. The material used to build 200 feet of this fence had been taken down at the Elevated Railway Approach where the new storage house now stands, and the iron remodeled by our blacksmith so as to conform with that section of fence already up at Pelham Parkway. Two coats of paint were given this fence. In continuing the fence from the Mansion Entrance Approach to the Linnaean Bridge on the eastern side of the Bronx River along Pelham Parkway, a 20-inch foundation 284 feet long and 3 feet deep was built.

The department of Parks placed trap rock and screening on the new road from the Rose Garden north to the Allerton Avenue entrance and rolled it down. Part of this road has been tarred, and we hope to open it to the public in the spring of 1924.

Five new rustic benches were constructed by the carpenter and ten were repaired. The signs and maps about the grounds were repaired and replaced when necessary. The propagating houses were supplied with wood fuel for four and a half months, cut from dead or fallen trees. We continued the uprooting of poison ivy.

From May until September, about twelve parties a week, consisting of from 50 to 2500 children visited the Garden. These children attended the public and Sunday schools throughout Greater New York and in New Jersey. The visitors were escorted to the three picnic grounds. Special guards were detailed there daily.

Two police officers in civilian clothes were stationed in the Garden for five days a week from May until September, including Sundays and Saturdays. In addition to our own keepers, twelve guards were selected from the laborers and gardeners and assigned to patrol the Garden on Sundays and holidays. A city officer has been detailed here every day in the year, and during the summer season three additional officers were assigned. The officers of the Police Department served about 250 summonses for violations of park ordinances and the offenders were fined

from two to ten dollars by city magistrates. The visitors to the Garden on Sundays, Saturdays, and holidays during the summer months averaged about 50,000, although this number was much greater in July and August.

Because of the vigilance of our employes, little damage was done to the plantations. A special guard was assigned to watch over the dahlia, gladiolus, and rose collections both day and night on account of the increasing number of admirers.

Respectfully submitted,
ARTHUR J. CORBETT,
Superintendent of Buildings and Grounds

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor of submitting the following report for the year 1923.

In addition to carrying on the current work of the past year, two special undertakings have been accomplished.

It has been our custom to store temporarily, in our preparation room, in the basement, such specimens as were without names, or which, for one reason or another, called for more attention than could be bestowed upon them at the time. Such materials gradually accumulated until they came to occupy most of our shelf-room and even to encroach on the floor space. During the past summer, the whole of this material has received attention, with the result that upward of a hundred specimens, some of exceptional interest, have been installed in our exhibition cases.

Classification of the large collection of economic material obtained on my last South American expedition has been continued. A point having been reached beyond which it was impracticable to proceed until the general botanical collection was studied, the latter part of the year has been devoted almost wholly to the latter work. This collection numbers more than 1500 species, and it appears that about ten per cent of them are undescribed. To the latter are referable a number of the economic products.

Of my drug collections, several have proved of great interest. The specimens of Coto collected by Dr. White have enabled us to make known, for the first time, the botanical identity of that drug, while recent information resulting directly from that expedition appears likely to clear up the origin of the related drug Paracoto. In these cases, our investigation has proceeded much farther than that of botanical identification. Two new alkaloids have been isolated from our Coto bark. The presence of additional alkaloids has been determined in another bark, and physiological experiments with one of them, now in progress, appear to indicate that it will prove of value in medicine.

The educational value of our Museum would be greatly enhanced if we could secure the conspicuous labeling of all specimens, with explanatory information in many cases, and I continue to urge this improvement as the most important requirement in this department.

Respectfully submitted,

H. H. RUSBY,

Honorary Curator of the Economic Collections

REPORT OF THE PALEOBOTANIST

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to report as follows upon paleobotanical and other activities in which I was engaged during the year 1923.

The principal item of investigation and research was the continuation and completion of my work on the fossil flora of the West Indies, which was extended beyond its original plan and scope so as to include, not only identifications and descriptions of all the available material in our collections, but also as complete a review as possible of the literature relating to the paleobotany of the region.

In coöperation with Prof. E. W. Berry, of Johns Hopkins University, Baltimore, a joint work on the Tertiary flora of Brazil was satisfactorily planned and prosecuted. My

special part of the work was the generic identifications of fossil specimens by comparison with specimens in the herbarium of the Garden; and in this connection I wish to acknowledge the assistance of Mr. Percy Wilson and Dr. H. A. Gleason.

A preliminary examination and report was made upon a collection of Pleistocene fossil plants from the Kootenay Valley of British Columbia, for the Canada Geological Survey. In return for this work a set of the specimens will become the property of the Garden and will make a valuable addition to the fossil plant collections.

Several requests were received for identification of paleobotanical material, and of material supposed to represent remains of fossil plants. These included a specimen of fossil wood from the Yellowstone National Park, fossil seeds or fruit from Colombia, and a supposed fossil banana from New Jersey. All received careful attention and were duly examined and reported upon.

Exchange of specimens was made with the State Museum of Stockholm, Sweden, and with Brown University, Providence, R. I.

Twenty-two pieces of literature relating to fossil botany were received and accessioned into the library. Twenty of these were personal exchanges. Three new authors were added to the exchange list. Continuous effort was maintained to augment this list and to secure as many separates as possible for the paleobotanical library.

From duplicate material in the fossil plant collections a set of thirty-five typical specimens was provided for educational purposes in Stuyvesant High School.

Four lectures, dealing in whole or in part with some phase of paleobotany, were delivered in connection with the regular Garden courses.

From June 25 to July 31 I made the instrumental observations and kept the records, in connection with the Hemlock Forest investigation; and on two occasions in September it was my privilege to be associated with representatives of

the Department of Water Supply in a reconnaissance of the surficial geological features of the Garden and adjacent region.

Respectfully submitted,

ARTHUR HOLLICK,

Paleobotanist

REPORT OF THE HONORARY CURATOR OF MOSSES

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: The accessions for the year 1923 number 729, and 680 duplicates have been distributed as exchanges.

We have received some rare and valuable exotic mosses, notably from the Swedish Pacific Expedition collected by Dr. Carl Skottsberg, and from Hawaii and Madagascar. Our collections from South America have been enriched by large additions from Colombia, made by Dr. F. W. Pennell and E. P. Killip, and from Venezuela by H. F. Pittier and W. E. Broadway. From the United States National Museum we have received collections to determine from Mexico, Nicaragua, Costa Rica, Honduras, and Panama, made by Paul Standley, W. R. Maxon, E. P. Killip and Dr. W. L. Abbott. A few specimens from Peru and Chile have also been added to the collection. Our West India exchanges have been continued in Cuba with Brothers León and Hioram, and in Porto Rico with the local herbarium at Rio Piedras. A few mosses from Jamaica and Santo Domingo have been added through the kindness of Prof. V. F. Brotherus, collected by E. Jaderholm in 1922.

No large collections from the United States have been added, though small accessions have come in for naming from Alaska, Washington, Texas, Florida, and South Carolina. We have received from Prof. J. M. Holzinger fascicle no. 20 of his Musci Acrocarpi Boreali-Americani and assisted him in some of his most critical determinations. Dr. Evans has continued his coöperation by naming our hepatics, and Mr. Williams devoted the summer to a large collection of rock lichens made in Porto Rico and the Virgin

Islands last winter, and is at work on the collection from Colombia made by Pennell and Killip. Professor Cockerell has contributed a few specimens from his trip to Siberia, and a few Chinese and Japanese specimens have also been presented.

I have continued to care for the collection of lantern slides, and 212 have been added during the year, either by gift or purchase, and 3221 have been in use by our own staff; a few loans have also been made.

Several lectures have been delivered to clubs in the vicinity of New York under the Stokes Fund for the preservation of our native plants, coöperating with the chapters of the Wild Flower Preservation Society of America. Many associate and coöperating clubs have been added to our list.

The correspondence has been heavy and continuous, and rarely a day has passed that some question has not been answered or literature distributed.

Respectfully submitted,

ELIZABETH G. BRITTON,

Honorary Curator of Mosses

REPORT OF THE HONORARY CUSTODIAN OF THE LOCAL HERBARIUM

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to present herewith my report for the year 1923, as Honorary Custodian of the Local Flora Herbarium.

The work of sorting and arranging the sheets has been carried on steadily by Mrs. Mitchell and has now covered about two-thirds of the collection.

Additions have been made to the extent of about 2000 sheets. Of these about 1200 sheets are the result of recent collecting, by Mr. Beals and others on Torrey Club trips; by Mr. Wilson, who has contributed nearly 600 sheets, mostly specimens collected last summer in Connecticut; and by the Custodian, chiefly in Passaic County, New

Jersey. Mrs. Mary Holtzoff has given 264 specimens, collected by her during several years in McLean's woods on the northern border of Bronx Borough. Mr. W. C. Ferguson contributed over 400 specimens from Long Island. Of the remainder, 18 sheets have been transferred from the general herbarium, about 100 have come from old collections, and a few have been given by Dr. Small, Dr. Hollick, Mr. W. C. Ferguson, and Miss Marguerite Lee.

Respectfully submitted,

H. M. DENSLOW,

Honorary Custodian of the Local Herbarium

SCHEDULE OF EXPENDITURES DURING THE YEAR 1923.

I. CITY MAINTENANCE ACCOUNT

	Appropriated	Expended	Balance
Salaries, Regular Employees	$142,839.00	$142,756.40	$ 82.60
Wages, Temporary Employees	12,796.80	12,796.80	
Total, Personal Service	$155,635.80	$155,553.20	$ 82.60
Forage and Veterinary Supplies	373.00	$ 371.79	$ 1.21
Fuel Supplies	25,050.00	25,038.71	11.29
Office Supplies	300.00	299.87	.13
General Plant Supplies	1,000.00	999.68	.32
General Plant Equipment	1,000.00	998.40	1.60
General Plant Materials	2,300.00	2,299.93	.07
Repairs and Replacements	3,500.00	3,494.39	5.61
Light, Heat and Power	350.00	348.04	1.96
Shoeing and Boarding Horses, including Veterinary Service	150.00	149.00	1.00
Telephone Service	150.00	146.97	3.03
Total, Expenses for other than Personal Service	$ 34,173.00	$ 34,146.78	$ 26.22
Summary, City Maintenance Account	$189,808.80	$189,699.98	$ 108.82

2. SPECIAL GARDEN ACCOUNTS

	Appropriated	Expended	Balance
PLANT FUND			
Balance from 1922	$ *237.48*		
Contributions	590.00		
Sale of Hay	85.00		
Refund	16.91		
Total	$ 929.39	$ 688.14	$ 241.25
SPECIAL BOOK FUND			
Balance from 1922	$ *25.18*		
Contributions	8,200.00		
Sale of Duplicate Books	1,415.00		
Total	$ 9,640.18	$ 9,537.42	$ 102.76
EXPLORATION FUND			
Contributions	$ 1,090.00	$ 1,083.86	$ 6.14

	Appropriated	Expended	Balance
MUSEUM AND HERBARIUM FUND			
Balance from 1922	$ 37.27		
Contributions	2,325.00		
Total	$2,362.27	$2,336.26	$26.01
SPECIAL DEVELOPMENT FUND			
Balance from 1922	$522.91		
Contribution	150.00		
Total	$672.91	$487.10	$185.81
PUBLICATION FUND			
Contributions	$2,834.03	$2,802.68	$31.35
LABORATORY FUND			
Contributions	$775.00	$555.11	$219.89
INVESTIGATION FUND			
Contributions	$861.00	$856.06	$4.94
LECTURE FUND			
Contributions	$350.00	$341.18	$8.82

3. SPECIAL INCOME ACCOUNTS

	Appropriated	Expended	Balance
Income of Science and Education Fund			
Public Instruction	$4,000.00	$3,600.00	$400.00
Income of Darius O. Mills Fund			
Scientific Supplies and Painting, Drawing, and Photography of Plants	$2,400.00	$2,394.47	$5.53
Income of Henry Iden Fund			
Books	$500.00		$500.00
Income of William R. Sands Fund			
Horticultural Prizes	$500.00		$500.00
Income of Olivia E. and Caroline Phelps Stokes Fund			
Preservation of Native Plants	$160.00	$159.25	$.75
Accumulated Income of Student's Research Fund			
Aid for Students' Research	$850.00	$365.00	$485.00
Income of David Lydig Fund			
Publications	$4,500.00	$4,485.59	$14.41
Income of Addison Brown Fund			
Publication of Addisonia	$3,000.00	$2,898.49	$101.51
Income of John Innes Kane Fund			
Plants for Grounds and Greenhouses	$500.00	$494.32	$5.68

	Appropriated	Expended	Balance
Income of Maria DeWitt Jesup Fund			
Increase of the Collections, Books Specimens, and Plants.....	$1,200.00	$1,003.96	$196.04
Accumulated Income of Charles Budd Robinson Fund			
Aiding Exploration.....	$80.00		$80.00
Income of Fanny Bridgham Fund			
Books and Binding Books.....	$1,700.00	$1,689.33	$10.67
Income of Francis Lynde Stetson Fund			
Lectures.....	$1,200.00	$1,172.51	$27.49
Accumulated Income of Russell Sage and Margaret Olivia Sage Fund			
Labor.....	$7,000.00	$6,919.80	$80.20
Fencing.....	5,800.00	5,770.72	29.28
Railings for Hemlock Grove.....	700.00	688.50	11.50
Repairs and Renewals.....	3,600.00	3,563.49	36.51
Salaries.....	16,300.00	16,293.37	6.63
Supplies and Materials.....	5,900.00	5,827.91	72.09
Total.....	$39,300.00	$39,063.79	$236.21

4. GENERAL INCOME ACCOUNT

	Appropriated	Expended	Balance
Insurance.....	$325.00	$316.10	$8.90
Entertainment of Guests and Meetings of Members.....	525.00	504.15	20.85
Assistance for Treasurer.....	1,080.00	1.080.00	
Circulars for Membership.....	1,200.00	1,187.07	12.93
Temporary Subsidy for Addisonia....	400.00		400.00
Contingent Fund.....	2,450.00	2,421.09	28.91
Salaries.....	13,400.00	11,789.92	1,610.08
Expenses of Honorary Curator of the Economic Collections.....	600.00	600.00	
Labor.....	8,000.00	7,942.80	57.20
Library Shelving and Herbarium Cases.....	3,000.00	2,991.95	8.05
Total.....	$30,980.00	$28,833.08	$2,146.92

SUMMARY OF EXPENDITURES FROM FUNDS OF THE GARDEN

Special Garden Accounts.....	$17.967.81
Special Income Accounts.....	57.326.71
General Income Account.....	28,833.08
Total.....	$104,127.60

5. BOARD ROOM FUND

RECEIPTS

January 1, 1923, Balance Cash.....		$12.40
Gross Receipts, January to April 16..	$63.58	
Less, credited to Garden Funds.....	1.68	
Net Receipts.....		61.90
Total.....		74.30

DISBURSEMENTS

Supplies.....	$23.20	
Contingencies.....	51.10	
Total.....		74.30

Respectfully submitted,
WALTER S. GROESBECK,
Bookkeeper.

E. and O. E.
NEW YORK, JANUARY 14, 1924.

DIRECTOR-IN-CHIEF'S ACCOUNT FOR THE YEAR 1923

466 Lexington Avenue
New York, April 1, 1924.

MR. ROBERT W. DE FOREST,
Chairman, Finance Committee, New York Botanical Garden,
30 Broad Street, New York, N. Y.

Dear Sir:

This is to certify that I have examined and audited the financial books and accounts of the Director-in-Chief of The New York Botanical Garden for the year nineteen hundred and twenty-three (1923), and that I find the same to be correct, and the cash balance to be as stated in the current cash book.

In accordance with recent practice, I have not included in the auditing the examination of the vouchers for City maintenance or construction work paid for by the City, as such vouchers have been found proper and in order by the City authorities, and it was decided in 1904 by the then Chairman of the Finance Committee that a further examination of them was unnecessary. By like authority I have omitted also a detailed examination of the annual membership dues account. These dues are received by the Director-in-Chief and forwarded by him to the Treasurer, the former keeping a detailed record of the same.

Respectfully submitted,
A. W. STONE, *Special Auditor.*

REPORT OF THE CHAIRMAN OF THE SCIENTIFIC DIRECTORS

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: The Scientific Directors have held their customary meetings throughout the year, at which many questions dealing with the present and future scientific work of the Garden have been brought up by the directors for discussion.

The possibility of extending the exploration and experimental research work of the Garden has received increasing attention. It has been found possible with the means and personnel now available to take up and study the conditions

of growth and reproduction of the native hemlock, a problem in which the Garden, as custodian of a fine native growth of these trees, has an especial interest. Under the direction of a committee of the Scientific Directors this study has already made considerable progress, especially in the accumulation of data as to temperature and moisture conditions in the hemlock grove in the Garden, and at a number of other representative localities in which native stands of hemlock are found.

The regular scientific work of the Garden has gone forward with normal vigor and is represented in additional numbers of the North American Flora, and various papers on genetics, as well as the maintenance of its regular serial publications. Especially noteworthy is the completion with the appearance of the 4th volume of the great monograph of "The Cactaceae" by Director Britton and Dr. Rose. The need of additional funds for the support of these publications, especially for the colored plates in *Addisonia*, and additional and more adequate illustrative material for the *Journal*, as well as for various special publications by members of the staff, is becoming more and more acute.

The Scientific Directors have participated fully, also, in the discussion of the proposals for the further improvement and development of the landscape features of the Garden and for the new decorative and educational plantations which are now under consideration.

Respectfully submitted,

R. A. HARPER,

Chairman

REPORT OF THE COMMITTEE ON PATRONS, FELLOWS AND MEMBERS FOR THE YEAR 1923.

To the Board of Managers of The New York Botanical Garden.

Gentlemen: The number of new members who have qualified is 166. The number of annual members is now 1327; life members, 126; sustaining members, 18.

Of the annual members 60 are now in arrears for dues for 1923, 25 for dues for 1922 and 1923, 14 for dues for 1921, 1922 and 1923.

Dues have been collected to the amount of $13,110.

One person has qualified as a fellow for life by the payment of $1000, and seven persons as life members by the payment of $250 each. These sums have been transmitted to the treasurer.

A complete list of all classes of members to date is herewith submitted.

Benefactors

*Mrs. Fanny Bridgham,
*Hon. Addison Brown,
*Andrew Carnegie,
Columbia University
*Hon. Charles P. Daly,
Daniel Guggenheim,
Murry Guggenheim,
*D. O. Mills,
*J. Pierpont Morgan, Sr.,
John D. Rockefeller,
*Mrs. Russell Sage,
*Francis Lynde Stetson,
*Cornelius Vanderbilt.

Patrons

Oakes Ames,
*Miss Catherine A. Bliss,
Dr. N. L. Britton,
*Hon. Addison Brown,
*Andrew Carnegie,
*Mrs. George Whitfield Collord,
*Mrs. Louisa Combe,
*James M. Constable,
*William E. Dodge,
James B. Ford,
*George J. Gould,
Edward S. Harkness,
*Mrs. Esther Herrman,
Archer M. Huntington,
*Henry Iden,
Mrs. John Innes Kane,
*John Stewart Kennedy,
*Mrs. Mary J. Kingsland,
*J. Pierpont Morgan, Sr.,
*Oswald Ottendorfer,

* Deceased

*Lowell M. Palmer,
*William Rockefeller,
*William R. Sands,
*William C. Schermerhorn,
*James A. Scrymser,
Mrs. Finley J. Shepard,
*Samuel Sloan,
*Mrs. Frederick F. Thompson,
*W. K. Vanderbilt,
Mrs. Antoinette Eno Wood.

Fellows for Life

Edward D. Adams,
George F. Baker,
Miss Elizabeth Billings,
Mrs. W. Bayard Cutting,
Dr. Robert W. de Forest,
Cleveland H. Dodge,
James B. Ford,
Daniel Guggenheim,
Murry Guggenheim,
S. R. Guggenheim,
William Halls Jr,
Mrs. Stephen V. Harkness,
Mrs. John Stewart Kennedy,
Mrs. Frederic S. Lee,
Ogden Mills,
J. P. Morgan,
E. A. Richard,
Mrs. John A. Roebling,
Mortimer L. Schiff,
Leon Schinasi,
Miss Olivia E. Phelps Stokes,
Charles G. Thompson,
Louis C. Tiffany,
Tiffany & Company.

Life Members

Edward D. Adams,
Dr. Felix Adler,
Mrs. James Herman Aldrich,
Dr. S. T. Armstrong,
Edward W. C. Arnold,
Mrs. Hugh D. Auchincloss,
Samuel D. Babcock,
Dr. John Hendley Barnhart,
George D. Barron,
Aurel Batonyi,
Gustav Baumann,
Samuel R. Betts,
William G. Bibb,
Miss Elizabeth Billings,
Mrs. Robert Woods Bliss,
George Blumenthal,
G. T. Bonner,
Mrs. Addison Brown,
J. Hull Browning,
Mrs. Andrew Carnegie,
T. Morris Carnegie,
Frank R. Chambers,
Hugh J. Chisholm,
Hugh J. Chisholm, Jr.,
Geo. C. Clark,
Banyer Clarkson,
Dr. James B. Clemens,
William F. Cochran,
W. R. Coe,
William Colgate,
Miss Georgette T. A. Collier,
W. E. Conner,
Mrs. F. A. Constable,
R. N. Cranford,
Melville C. Day
Charles Deering,
Mrs. John Ross Delafield,
Maturin L. Delafield,

* Deceased

W. B. Dickerman,
Miss Josephine W. Drexel,
Miss Ethel DuBois,
William A. DuBois,
George E. Dunscombe,
Thomas Dwyer,
George Ehret,
Ambrose K. Ely,
Dr. John F. Erdmann,
Edward J. Farrell,
Marshall Field,
Mrs. H. J. Fisher,
Andrew Fletcher,
Charles R. Flint,
Eugene G. Foster,
Mrs. John French,
Childs Frick,
Mrs. Theodore Kane Gibbs,
Daniel Guggenheim,
Bernard G. Gunther,
Franklin L. Gunther,
Charles J. Harrah,
Dr. Louis Haupt,
R. Somers Hayes,
Archer M. Huntington,
Frank D. Hurtt,
James H. Hyde,
Mrs. Columbus O'D. Iselin,
Dr. Walter B. James,
Miss Annie B. Jennings,
Mrs. David J. Kelley,
Nathaniel T. Kidder,
H. R. Kunhardt,
W. B. Kunhardt,
Charles Lanier,
W. V. Lawrence,
Mrs. George Lewis,
Joseph Loth,
William H. Macy, Jr.,
Louis Marshall,
Edgar L. Marston,
William J. Matheson,
C. W. McAlpin,
Emerson McMillin,
Dr. George N. Miller,
A. G. Mills,
Mrs. William F. Milton,
Dr. Lewis R. Morris,
Newbold Morris,
Sigmund Neustadt,
A. Lanfear Norrie,
Gordon Norrie,
George M. Olcott,
Mrs. Charles Tyler Olmstead,
William Church Osborn,
W. H. Perkins,
Curt G. Pfeiffer,
Gustavus A. Pfeiffer,
M. Taylor Pyne,
John J. Riker,
J. C. Rodgers,
Thomas F. Ryan,
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Dr. Reginald H. Sayre,
Edward C. Schaefer,
Mortimer L. Schiff,
Mrs. I. Blair Scribner,
George Sherman,
James Shewan,
James Speyer,
Miss Ellen J. Stone,
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Charles G. Thompson,
Robert M. Thompson,
William Thorne,
William Stewart Todd,
Oswald W. Uhl,
Miss Anna Murray Vail,
F. T. Van Beuren,

Mrs. C. Vanderbilt,
F. M. Warburg,
John I. Waterbury,
Miss Emily A. Watson,
S. D. Webb,
Dr. W. Seward Webb,
John D. Wing,
Mrs. Anna Woerishoffer.

Sustaining Members

Robert Breckinridge Baird,
Miss Elizabeth Billings,
Miss Mary T. Bryce,
Homer A. Dunn,
John Greenough,
Mrs. E. V. C. Hawkes,
O. H. Kahn,
Mrs. Frida Merz Krollpfeiffer,
Edgar L. Marston,
George Grant Mason,
Arthur M. Mitchell,
William Church Osborn,
William H. Porter,
Mrs. James T. Pyle,
Prof. J. E. Spingarn,
William R. Stewart,
Charles Strauss,
Arthur Hays Sulzburger.

Annual Members

Dr. Robert Abbe,
Benjamin Abert,
Fritz Achelis,
John Achelis,
C. E. Adams,
Mrs. Elbridge L. Adams,
F. B. Adams,
Henry S. Adams,
Maurice D. Adams,
Mrs. George B. Agnew,
J. E. Aldred,
Mrs. Winthrop W. Aldrich,
Sir Douglas Alexander, Bart.,
Mrs. Frederick Allen,
James F. Allen,
Philip Allen,
Mrs. S. W. Allerton,
Mrs. O. P. Amend,
Mrs. Copley Amory,
P. Chauncey Anderson,
J. M. Andreini,
Miss Charlotte L. Andrews,
D. A. Ansbacher,
Mrs. John F. Archbold,
Mrs. George A. Archer,
Francis J. Arend,
Reuben Arkush,
Mrs. H. O. Armour,
Dr. William Aronstein,
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E. Asiel,
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Mrs. E. S. Auchincloss, Jr.
John W. Auchincloss,
Chellis A. Austin,
Ledyard Avery,
Charles F. Ayer,
Frank L. Babbott,
Jules S. Bache,
Charles Baird,
Miss Charlotte S. Baker,
George F. Baker,
Stephen Baker,
Albert H. Baldwin,

A. T. Baldwin,
Frederick H. Baldwin,
George V. N. Baldwin, Jr.,
William D. Baldwin,
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Chris Bambach,
Louis Bamberger,
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Mrs. A. Battin,
Mrs. Martha Battle,
Felice Bava,
Mrs. L. P. Bayne,
Jeremiah Beall,
John D. Beals,
Lewis Bechtold,
Mrs. Margeret B. Becker,
Frank Begrisch, Jr.,
Mrs. A. Frederick Behre,
Dr. Otto F. Behrend,
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Louis V. Bell,
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A. Beller,
August Belmont,
Alex. Benecke,
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J. Philip Benkard,
Bruno Benziger,
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Issac J. Bernheim,
Charles L. Bernheimer,
Miss Rosie Bernheimer,
Philip Berolzheimer,
Edward J. Berwind,
George N. Best,
Eugene P. Bicknell,
Mrs. George Biddle,
Mrs. Sylvan Bier,
Nathan I. Bijur,
Samuel H. Bijur,
Raymond Bill,
C. K. G. Billings,
Cecil Billington,
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James C. Bishop,
George H. Bissinger,
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Frederick S. Blackall,
H. C. Blackiston,
Mrs. Dexter Blagden,
Mrs. Emmons Blaine,
Mrs. C. Ledyard Blair,
J. Insley Blair,
Isidore Blauner,
C. N. Bliss, Jr.,
Miss S. D. Bliss,
Mrs. Walter P. Bliss,
Mrs. M. J. Bluen,
Hugo Blumenthal,
Sidney Blumenthal,
Miss R. C. Boardman,
H. D. Bob,
Henry W. Boettger,
Robert Boettger,
Theodore Boettger,
William H. Bolton,
Mrs. Sydney C. Borg,
Louis Boury,
Miss Edith G. Bowdoin,
George T. Bowdoin,
George P. Bowman,
John McE. Bowman,

Miss Mabel Boyd,
Mrs. Jennie M. Breitenbach,
Mrs. E. N. Breitung,
Henry Kelly Brent,
George P. Brett,
Mrs. Benjamin Brewster,
George S. Brewster,
Hans V. Briesen,
John R. Brinley,
Mrs. Willard C. Brinton,
Jno. I. D. Bristol,
Miss H. Louise Britton,
Richard H. Britton,
Dr. Edward B. Bronson,
Bronx Hay & Grain Co.,
Mrs. H. D. Brookman,
Ernest C. Brower,
Miss Aneita D. Brown,
Charles Hilton Brown,
Dickson Q. Brown,
Edwin H. Brown,
Franklin Q. Brown,
Mrs. Franklin Q. Brown,
Mrs. Harold Brown,
M. Bayard Brown,
Mrs. Thatcher M. Brown,
Vernon C. Brown,
Mrs. J. Hull Browning,
M. Brukenfeld,
Charles E. Bryant,
Thomas B. Bryson,
Miss Emily Buch,
Miss Anna J. Buechner,
Mrs. Jonathan Bulkley,
Dr. L. Duncan Bulkley,
Dr. Edward S. Burgess,
Louis Burk,
Thomas Burkhard,
E. R. Burnett,
William J. Burns,

Algernon T. Burr,
William F. Burt,
Mrs. Wendell L. Bush,
Charles S. Butler,
Miss Emily O. Butler,
H. A. Caesar,
James P. Cahen,
E. T. Caldwell,
Prof. Otis W. Caldwell,
W. R. Callender,
Henry L. Calman,
H. H. Cammann,
Henry L. Cammann,
Mrs. Agnes D. Camp,
Mrs. John Campbell,
H. W. Cannon,
Mrs. Charles F. Cantine,
Harry Caplin,
Mrs. Lister Carlisle,
Mrs. George L. Carnegie,
Arthur L. Carns,
Mrs. Ernest T. Carter,
S. C. Cary,
George B. Case,
Miss Marian Roby Case,
Alvin C. Cass,
Miss Jennie R. Cathcart,
Robert M. Catts,
O. E. Chaney,
Norman Wilmer Chandler,
Mrs. Winthrop Chanler,
Miss Cornelia Van A. Chapin,
Miss Maria Bowen Chapin,
John Jay Chapman,
Miss Jessie Chase,
José Edward Chaves,
H. Durant Cheever,
Mrs. George L. Cheney,
Miss Mary Cheney,
Paul H. Cheney,

Geo. E. Chisholm,
B. Ogden Chisolm,
Mrs. Joseph H. Choate,
Miss Mabel Choate,
Mrs. Helen L. Chubb,
Percy Chubb,
Charles T. Church,
Richard N. L. Church,
Church of our Lady of Mercy,
John Claflin,
Mrs. Edward H. Clark,
F. Ambrose Clark,
Mrs. George Halford Clark,
Hon. W. A. Clark,
William Clark,
E. A. S. Clarke,
Lewis L. Clarke,
Albert Clayburgh,
G. D. Cochran,
Miss Mary T. Cockcroft,
C. A. Coffin,
Edmund Coffin,
William Edward Coffin,
E. W. Coggeshall,
H. Z. Cohen,
William N. Cohen,
William W. Cohen,
J. L. Coker,
Mrs. Rufus Cole,
Charles B. Colebrook,
Mrs. Lathrop Colgate,
William Colgate,
Barron G. Collier,
Mrs. Richard C. Colt,
Miss Mary Compton,
Martin Conboy,
T. G. Condon,
Stephen D. Conger,
Hermann Conheim,
Joseph Conners,
Mrs. E. C. Converse,
J. N. Conyngham,
Dr. Robert A. Cooke,
Arthur N. Cooley,
Marin LeBrun Cooper,
Mrs. Marin LeBrun Cooper,
Miss Louise I. Corell,
C. R. Corning,
H. C. Cornwall,
J. George Costello,
Mrs. Charles Henry Coster,
Mrs. Clarkson Cowl,
J. Howard Cowperthwait,
Miss Louise G. Crabbe,
Miss Lily C. Cram,
Charles R. Crane,
George F. Crane,
Mrs. Jonathan H. Crane,
William Crawford,
Miss Mary C. Crimmins,
Mrs. Thomas Crimmins,
George A. Crocker, Jr.,
Mrs. W. H. Crocker,
Rev. W. T. Crocker,
James W. Cromwell,
Miss Mary R. Cross,
Mrs. R. J. Cross,
W. Redmond Cross,
W. D. Crouch,
Mrs. Joseph F. Cullman,
Mrs. E. B. Currier,
B. A. Cushman,
R. Fulton Cutting,
Miss Eleanor De Graff Cuyler,
Jean de Saint Cyr,
Mrs. Chester Dale,
Frederic A. Dallett,
Mrs. Ira Davenport,
DeWitt A. Davidson,
J. Clarence Davies,

R. C. Davis,
Mrs. Thomas B. Davis,
Alvah Davison,
Mrs. Henry P. Davison,
Clarence S. Day,
Henry Dazien,
Henry L. de Forest,
Dr. Robert W. de Forest,
Mrs. Robert W. de Forest,
John F. Degener, Jr.,
Mrs. Carlos de Heredia,
Lyman Delano,
Moreau Delano,
William Adams Delano,
William C. DeLanoy,
Countess de Laugier-Villars,
Edwin H. Denby,
John B. Dennis,
Rev. H. M. Denslow,
William P. Deppe,
Walter D. Despard,
Julian F. Detmer,
Lee Deutsch,
Miss Harriet N. Devotion,
William G. De Witt,
J. Henry Dick,
George H. Diehl,
Charles F. Dieterich,
H. O. Dill,
Miss Mary A. Dill,
Mrs. Alfred P. Dix,
Miss Gertrude Dodd,
Cleveland H. Dodge,
Mrs. Cleveland H. Dodge,
Edward I. Doheny,
L. W. Dommerich,
Otto L. Dommerich,
Gustave Donat,
Mrs. Ruger Donoho,
Charles Doscher,
Henry Doscher,
Mrs. Frank Nelson Doubleday,
Miss Elizabeth Douglas,
Mrs. George William Douglas,
Walter Douglas,
Joseph Dowd,
W. E. Dowd, Jr.,
William J. Downer,
Tracy Dows,
Mrs. B. F. Drakenfeld,
Miss Dorothea A. Dreier,
J. R. Drexel,
S. F. Dribben,
Isaac W. Drummond,
Mrs. Matthew B. DuBois,
F. L. Du Bosque,
Miss Elizabeth B. Dunlap,
H. F. du Pont,
Pierre S. du Pont,
Mrs. P. S. du Pont,
Mrs. T. Coleman du Pont,
William du Pont,
Miss Amy C. Duryee,
E. G. Duvall,
John E. Dwight,
Mrs. Winthrop Dwight,
Joseph N. Early,
Mrs. Frederick H. Eaton,
Mrs. Charles N. Edge,
Thomas C. Edmonds,
Mrs. J. S. Ehrich,
Mrs. Ernest Ehrmann,
Karl Eilers,
August Eimer,
William Einstein,
Max Eisman,
Martin Elkind,
Howard Elliott,
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Mrs. T. Wolfson,
Mrs. William H. Woodin,
Dr. John Woodman,
Prof. R. S. Woodward,
Park M. Woolley,
Mrs. I. Maurice Wormser,
Miss Julia Wray,
Mrs. J. Hood Wright,
Richardson Wright,
Gustave A. Wuefel,
Dr. Peter B. Wyckoff,
Mrs. A. Murray Young,
Owen D. Young,
Mrs. Cornelius A. Zabriskie,
George A. Zabriskie,
Henry C. Zaro,
Mrs. Anna M. von Zedlitz,
Charles H. Zehnder,
Albert G. Zimmermann,

August Zinsser,
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Henry Zuckerman.

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Mrs. E. Henry Harriman,
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Miss Olivia E. P. Stokes.

REPORT OF THE TREASURER

NEW YORK, JANUARY 14, 1924

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: I transmit herewith the Treasurer's Report from January 1st, to December 31st, 1923, showing a statement of the receipts and disbursements.

Respectfully submitted,

JOHN L. MERRILL,

Treasurer

RECEIPTS AND DISBURSEMENTS

Receipts

Balance January 1, 1923		$20,648.51
Income from General Investments		19,287.50
Income from Investment Sage Fund		36,748.50
Endowment Fund for Science and Education		8,375.00
Contributions from New York City		169,724.13
C. B. Robinson Memorial Fund		49.10
Income from Special Funds		
Special Trust Fund	$255.00	
Mills Fund	6.00	
D. Lydig Fund	3,526.46	
Stokes Fund	17.40	
C. B. Robinson Memorial Fund	10.00	
Sage Fund	100.00	3,914.86
Contributions		
Publication Fund	$2,834.03	
Plant Fund	691.91	
Special Development Fund	150.00	
Sustaining Members	425.00	
Annual Dues	12,645.00	
Subscriptions to Addisonia	2,246.61	
Life Membership Fees	1,750.00	
Museum & Herbarium Fund	2,325.00	
Special Book Fund	9,615.00	
Exploration Fund	1,090.00	

Lecture Fund.....	350.00	
Investigation Fund.....	861.00	
Laboratory Fund.....	775.00	35,758.55
Refunds		
Miscellaneous Sales.....		176.95
Interest on Deposits.....		809.85
Investments		
Sage Fund		
Sale 10 shares Importers & Traders National Bank.....		7,500.00
Margaret Olivia Sage Fund		
Cash distribution to residuary legatees		
Third distribution to residuary legatees...	$50,000.00	
Advance in anticipation of further distribution	25,000.00	75,000.00
		$377,992.95

Disbursements

Paid through Director-in-Chief,	
Account of City appropriations	$169,724.13
Special Book Fund.....	5,177.00
Vouchers Paid.....	31,127.20
Special Development Fund....	754.40
Museum & Herbarium Fund..	2,318.81
Plant Fund.....	599.64
Emma Jones Legacy.....	1,000.00
Exploration Fund.....	1,069.62
Publication Fund.....	1,009.81
Lecture Fund.....	309.18
Investigation Fund.....	774.48
Laboratory Fund.....	482.63
Account Kane Fund (Income).	392.27
Account A. Brown Fund (Income).....	2,241.72
Account Students' Research Fund (Income).....	365.00
Account Lydig Fund (Income)	4,524.50

Account Sage Fund (Income)..	41,390.46	
Account Science and Education Fund (Income).....	4,337.57	
Account Jesup Fund (Income).	1,131.09	
Account Mills Fund (Income).	2,197.30	
Account Stokes Fund (Income)	335.29	
Account Bridgham Fund (Income).....	1,675.75	
Account Stetson Fund (Income).....	903.17	$273,841.02
Income General Investments		
Half of annual payment to Mrs. Staples, in accordance with agreement.....	500.00	
Commission to New York Trust Co., for collecting income...	92.89	
Special Trust Fund.....	255.00	847.89
Income Investment Sage Fund Adjustments		
Commission to New York Trust Co., for collecting income.....	129.64	
Adjustment of interest on purchase of securities.....	171.11	
Adjustment of income between accounts.....	1,512.50	1,813.25
General Income		
Miscellaneous expenditures.....		334.10
Investment Sage Fund		
Purchase of securities		
70 shares National Bank of Commerce.....	20,475.00	
$35,000 Chic. Mil. & St. Paul 4s.....	25,637.50	
$28,000 Gt. Western Power Power Co., 5s.....	25,550.00	71,662.50

Balance		
New York Trust Co.....	529.44	
J. P. Morgan & Co.....	28,964.75	29,494.19
		$377,992.95

Ledger Balances, December 31, 1923

Permanent Funds	*Debit*	*Credit*
Endowment Fund.....		$271,760.00
Endowment Fund for Science & Education...		91,836.90
David Lydig Fund.....		34,337.86
William R. Sands Fund.....		10,000.00
Francis L. Stetson Fund.....		25,000.00
Darius O. Mills Fund.....		50,000.00
Charles P. Daly Trust Fund.....		19,636.34
Henry Iden Fund.....		10,000.00
Addison Brown Fund.....		21,850.00
John Innes Kane Fund.....		10,000.00
Stokes Fund.....		3,000.00
Charles Budd Robinson Memorial Fund.....		755.04
Students' Research Fund.....		4,488.00
Maria DeWitt Jesup Fund.....		25,000.00
Margaret O. Sage Fund.....		660,823.88
Fanny Bridgham Fund.....		30,000.00
Special Trust Fund.....		17,000.00
General Investments		
As per Schedule A.....	$521,488.86	
Investment Special Trust Fund		
Gift of 170 shares All America Cables, Inc.....	17,000.00	
Investment Sage Fund		
As per Schedule B.....	671,576.68	
Temporary Funds		
Reserve Fund.....	8,558.75	
Special Book Fund.....		4,463.14
Special Development Fund.....		672.91
Plant Fund.....		561.09
Exploration Fund.....		48.42

Museum & Herbarium Fund		43.46
Lecture Fund		40.82
Investigation Fund		86.52
Laboratory Fund		292.37
Publication Fund		1,824.22
General Income	7,176.83	
Income Accounts		
Income of Maria DeWitt Jesup Fund		45.94
Income of David Lydig Fund	3,134.19	
Income of Darius O. Mills Fund	1,034.93	
Income of Stokes Fund		95.52
Income of Students' Research Fund		661.29
Income of Science & Education Fund	157.95	
Income of John Innes Kane Fund		492.33
Income of Henry Iden Fund	142.23	
Income of Addison Brown Fund		1,019.59
Income of William R. Sands Fund		522.46
Income of Charles B. Robinson Memorial Fund		84.15
Income of Margaret Olivia Sage Fund	6,822.12	
Income of Fanny Bridgham Fund	577.72	
Income of Francis Lynde Stetson Fund		722.20
Director-in-Chief, Working Fund	30,000.00	
Cash Balance, December 31, 1923	29,494.19	
	$1,297,164.45	$1,297,164.45

General Investments

Schedule A

$50,000 Ches. & Ohio Ry. 4½s	$47,875.00
$50,000 Southern Ry. 5s	54,604.17
$50,000 Erie Ry. 4s	46,145.84
$59,000 Erie Ry. 4s	54,713.75
$24,000 U. S. Govt. 2nd Liberty Loan Bonds, 4¼s.	24,060.00
$50,000 Reading Ry. 4s	46,750.00

$10,000 New York City 4s	9,936.25
$50,000 Penn. Ry. 4½s	50,500.00
$10,000 New York Cent. Ry.	9,510.48
$10,000 Balto. & Ohio Ry. 5s	10,025.00
$11,000 Milw. Sparta & N. W. Ry. 4s	10,120.00
$37,000 Nor. Pac. Ry. 4s	34,058.75
$10,000 Third Liberty Loan	10,000.00
$35,000 Great Nor. Ry. 7s	33,775.00
$25,000 Provident Loan Soc. Ctfs	25,000.00
$ 1,000 New York City 4¼s	990.00
$ 9,000 New York City 4s	8,718.75
$10,000 Niagara Falls Power Co	9,550.00
$ 5,000 Nash. Chat. & St. Louis Ry. Equip. 6s	5,069.85
$ 5,000 Cin. N. O. & Tex. Ry. Equip. 6s	5,086.02
$25,000 Provident Loan Soc. Ctfs	25,000.00
	$521,488.86

Investment of Sage Fund

Schedule B

Stocks

52 shares Bankers Trust Co.	$19,500.00
250 shares U. S. Steel, Pfd.	27,359.37
400 shares American Telephone & Telegraph Co.	37,775.00
80 shares American Telephone & Telegraph Co.	8,000.00
200 shares Atch. Top. & St. Fé Pfd	14,525.00
100 shares Mo. Kan. & Tex. Ry. Common Stock $1,400, par value, Mo. Kan. & Tex. Ry. Pr. Lien 6s $600, par value, Mo. Kan. & Tex. Ry. Adj. Mtg. 5s	3,208.00
100 shares American Tel. & Cable Co.	5,075.00
100 shares Union Pacific Ry. Pfd.	6,237.50
70 shares National Bank of Commerce	20,475.00

Bonds

$10,000 Oregon Wash. R. R. & Nav.	6,500.00
$19,000 N. Y. Telephone 1st. Gen	14,155.00
$ 6,000 Balt. & Ohio P L. 3½s	4,860.00
$ 7,000 Wash. Terminal 1st 3½s	4,830.00
$15,000 Mich. Cent'l Eq. 6s	15,193.50
$10,000 N. Y. Central Eq. 6s	10,163.02
$15,000 Chic. & No. Western Ry. Eq. 6s	15,228.49

$15,000 Southern Pacific R. R. 4s	11,962.50
$15,000 Illinois Central Eq. 6s	15,211.49
$15,000 Atlantic Coast Line Cons. Mtge	12,112.50
$15,000 Union Pacific 1st & L. G	12,637.50
$15,000 Chic. Burl. & Quincy Gen. Mtge	12,112.50
$15,000 Norf. & Western Ry. 1st Cons. Mtge	12,037.50
$15,000 N. Y. Central Ry. Cons. Mtge. 4s	11,212.50
$10,000 Pac. Gas & Electric Co	8,925.00
$10,000 Illinois Central Eq. 6s	10,128.08
$10,000 Chic. & No. Western Eq. 6s	10,151.50
$10,000 Pitts. McK. & Yough. Eq. 6s	10,151.50
$10,000 Nash. Chatt. & St. L. Ry. Eq. 6s	10,162.24
$10,000 Cin. N. Orleans & Tex. Pac. Eq. 6s	10,181.97
$10,000 N. Y. Telephone Ref. Mtge	10,040.00
$ 1,000 Gen. Electric Gold Deb	971.50
$ 4,000 Gen. Electric Gold Deb	3,866.00
$ 9,000 Amer. Smelt. & Ref. 1st Mtge	7,809.75
$ 1,000 Amer. Smelt. & Ref. 1st Mtge	871.50
$ 5,000 General Electric Co	4,838.75
$20,000 Louisville & Nash. Ry. Eq. 6s	20,302.63
$20,000 Atlantic Coast Line Eq. 6s	20,363.64
$50,000 Provident Loan Soc. Ctfs	50,000.00
$35,000 Norfolk & Western 4s	30,931.25
$11,000 New York Central 4s	9,253.75
$13,000 Northern Pacific 4s	11,293.75
$15,000 Chic. Burl. & Quincy 4s	13,481.25
$30,000 Commercial Cables Co. 4s	22,500.00
$ 5,000 Liggett & Myers 5s	4,938.75
$15,000 P. Lorillard 7s	17,437.50
$10,000 New Brunswick Southern 1st 3s	8,100.00
$ 2,000 Minn. St. Paul & Sault St. M. 1st. 4s	1,735.00
$ 5,000 Rochester Ry. & Light 5s	4,475.00
$ 4,000 Balt. & Ohio Wn. Div. 1st 3½s	3,490.00
$ 6,000 Buffalo Gen'l Electric 1st 5s	5,640.00
$ 4,000 N. Y. Central Ry. 4s	3,165.00
$ 4,000 Chic. Rock Is. & Pac. Ry. 4s	3,070.00
$ 2,000 Pennsylvania Ry. Co. Gen. 4½s	1,742.50
$35,000 Chic. Milw. & St. Paul 4s	25,637.50
$28,000 Great Western Power Co. 5s	25,550.00
	$671,576.68

Treasurer's Account for the Year 1923

466 Lexington Avenue
New York, April 1, 1924.

Mr. Robert W. de Forest,
Chairman, Finance Committee, New York Botanical Garden,
30 Broad Street, New York, N. Y.

Dear Sir:

This is to certify that I have, by direction of the Board of Managers, examined the books and accounts of the Treasurer of The New York Botanical Garden, for the year nineteen hundred and twenty-three (1923), together with their proper vouchers, and that I find the balance sheet and the Treasurer's statement of receipts and disbursements attached hereto to be correct.

The various investment securities have also been verified and accounted for, and I certify that the statement of the same reported in the balance sheet of December 31, 1923, is correct.

Respectfully submitted,
A. W. Stone, *Special Auditor.*

VOL. 12 No. 45

BULLETIN

OF

THE NEW YORK BOTANICAL GARDEN



ISSUED SEPTEMBER 13, 1924

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BULLETIN
OF
The New York Botanical Garden

Vol. 12 No. 45

A Review of the Fossil Flora of the West Indies, with Descriptions of New Species

By Arthur Hollick

(Plates 1–15)

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INTRODUCTION

General Remarks

Comparatively little is known and but little has been recorded in regard to the fossil flora of the West Indies, although numerous reports on and descriptions of the geology of the principal islands and groups of islands have been published. The fossil faunas, especially the mollusca, have been studied and utilized quite extensively in the interpretation of the stratigraphy, but the paleobotanical remains have received relatively little attention. Until the past two or three years, in fact, no systematic descriptions or illustrations of the fossil floras had been published, except in connection with a few species of coralline algae and certain specimens of silicified wood; but the specific and generic identifications of many of the latter do not appear to be satisfactory or conclusive, and certain others are unaccompanied by adequate descriptive text or illustrations. In recent years, however, remains of leaves and fruit, collected on several of the islands by various parties, have been subjected to critical examination, and it is largely on the study of this material that the present contribution is based. The islands on which fossil plant remains of one kind or another have been collected and examined now include Antigua, Saint Bartholomew, Anguilla, Martinique, Trinidad, Curaçao, Porto Rico, Hispaniola, Jamaica, and Cuba, each of which will be separately discussed.[1]

[1] Any extended discussion of the stratigraphic relations of the plant-bearing beds will not be attempted. Those who have studied the stratigraphy in the field, and those who have based conclusions on studies of the fossil faunas, are not always in agreement in regard to the exact geologic horizon to which certain beds or formations should be referred, and the fossil floras have not been of much assistance in this connection, other than that of confirming the Tertiary or Cre-

Historical Review

Antigua

Probably the earliest references to and descriptions of fossil plant remains from any part of the West Indies were in connection with the fossil woods of Antigua. In the early part of the eighteenth century Scheuchzer [1] listed a specimen of this material (*op. cit.*, p. 102) as "*Lithoxylon* ex Insula Antego . . . Lignum fossile"; but the record is now merely of historical interest and is of no scientific value.

About a century later, in an unsigned article on "Petrified wood from Antigua," [2] the statement may be found that "we are under obligation to Mr. Pelatiah Perit of New York, for a collection of specimens of silicious petrefactions of wood from Antigua . . . the specimens are principally the holzstein of Werner. . . . According to the information of Mr. Perit they are scattered over the surface of the island . . . with a profusion hardly less than that which Horneman observed of the same mineral during his travels over the eastern part of the great African desert. . . ."

Shortly after this a paper by Nugent [3] was published, under the title "A sketch of the geology of the Island of Antigua," in which he mentions a stratified rock at Monk's Hill, and remarks: that "the conglomerate character of this rock is derived from its having imbedded and incorporated with it, numerous fragments of all sizes of petrified wood . . . and other substances . . . the quantity and variety of the substances included, especially of petrified wood, is most astonishing. The siliceous woods are all apparently of the tropical kinds, and those of the palm tribe are among the most common . . . I have found, several times, petrified, the bulbous part of the cocoanut palm, where it emerges from the ground, and with the radicles which lace it thereto. One of the most remarkable specimens of fossil

taceous age of the rocks in which the fossil plant remains were found. Published formation or group names will be used in connection with the several plant-bearing deposits, whenever necessary to identify them stratigraphically, but it should be recognized that the Eocene, Oligocene, Miocene or Pliocene age of certain of the formations can not be regarded as definitely settled.

[1] Scheuchzer, J. J. Herbarium diluvianum, ed. 2. Leyden, 1723.

[2] Amer. Journ. Sci., vol. 1, pp. 56–57. 1818. [Probably by the editor, Benjamin Silliman.]

[3] Nugent, Nicholas. Geol. Soc. London, Trans. vol. 5, pp. 459–475. 1821.

wood I met with in the pasture near Paynter's estate, the trunk of a tree about twelve feet in length and as many inches in diameter, rent crosswise asunder, but all the parts lying contiguous to one another."

In 1831 Witham[1] listed and figured six specimens of fossil wood from Antigua (*op. cit.*, pp. 39–40, pl. 6, figs. 11–16), but without naming them and with only very meager descriptions. Figure 11 was described as "Fossil silicified dicotyledonous wood . . . the structure greatly resembles that of the mahogany . . ."; figures 12 and 13 were merely designated as "dicotyledonous"; figure 14 as "probably dicotyledonous";[2] and figures 15 and 16 as "monocotyledonous."

In 1834 Nicol[3] referred briefly to the Antigua fossil wood as follows (*loc. cit.*, p. 155): "I have examined upwards of a hundred specimens of fossil wood, from the tertiary formation of the island of Antigua. . . . The specimens . . . were chiefly dicotyledons, the rest monocotyledons."

The first specific descriptions of this material were by Unger,[4] about 1835–1840, who described five species of fossil palms, based upon the characters of the wood structure in certain specimens, *viz.*:

Fasciculites antiguensis n. sp., p. LVIII, pl. 2, figs. 5–7.
Fasciculites withami n. sp., p. LVIII. (= Witham's figs. 15, 16, *op. cit.*)
Fasciculites palmacites (Sprengel) Cotta, p. LIX, pl. 3, fig. 6.
Palmacites crassipes n. sp., p. LX.
Flabellaria antiguensis n. sp., p. LXIII, pl. 2, figs. 2–4.

Fossil leaves as well as wood were mentioned by Hovey[5] in his "Geology of Antigua," a number of which he determined as identical with existing tropical genera and species. Following is an abstract of his observations in connection with the fossil flora:

[1] Witham, Henry. Observations on fossil vegetables, etc. London, 1831.

[2] This specimen was subsequently described by Unger (Synopsis plantarum fossilium, p. 228. 1845) as *Hauera americana*, a new genus and species, which he included in the Thymelaeaceae.

[3] Nicol, William. Observations on the structure of recent and fossil coniferae. Edinburgh New Philos. Journ., vol. 16, pp. 137–158, pls. 2–4; pp. 310–314, pl. 5. 1834.

[4] Unger, Franz. De palmis fossilibus, [in] Martius' Historia naturalis palmarum, vol. 1, chap. 2, pp. LIII–LXX, pls. (geol.) 1–3. 1823–1850.

[5] Hovey, Sylvester. Amer. Journ. Sci., vol. 35, pp. 75–85. 1839.

On page 79 he refers to a clay formation and says that "with the exception of some petrified leaves found near its junction with the trap at Drew's Hill, I could not ascertain that any organic remains had been discovered in it. These leaves belong to trees of the dicotyledonous class. Dr. Nicholson [1] thinks he recognizes among them those of *Ficus partusa* and a species of *Melastoma*." Mention is also made of the occurrence of both animal and plant remains in the vicinity of Constitution Hill and, on page 81, he says: "But the most striking feature of all is the perfect preservation of the form and structure of the petrified substances, even of such as in a living state are most delicate. For example, the opening leaves of the banana . . . have been converted into silex and perfectly preserved. I saw myself the petrified pod of a tamarind, so entire in its shape and all its parts, that no one could mistake it. . . . But the most interesting class of fossils is the silicified wood—the ordinary trees and shrubs of the climate still retaining their individual structures, but converted into the choicest mineral substances. . . . Among these may be particularly specified . . . the loblolly (*Pisonia subcordata*). The cocoanut, also, is often very beautiful . . . the most of these fossils, I do not doubt, are relics of shrubs and trees identical with those now growing upon the island, though some others are probably extinct."

In 1840 Stokes [2] incidentally referred to a specimen of fossil wood from Antigua, in connection with a description of a specimen of fossil wood from Germany, as follows (*loc. cit.*, p. 208): "Mr. Robert Brown, to whom I had the pleasure of showing this specimen from Germany . . . reminded me of one of silicified wood from Antigua . . . represented in the accompanying drawing (Pl. XVII)." The entire specimen is shown, natural size, in figure 1 on the plate cited, and a portion, magnified ten times, in figure 2; but the author does not give any hint or suggestion as to its probable or possible botanical affinities.

[1] Nicholson, Thomas. Antigua almanac and register. [Cited by Lester F. Ward in his "Geographical distribution of fossil plants," p. 819 (U. S. Geol. Survey, Eighth Ann. Rept. 1886–87), but without pagination or date of publication. I have not seen Nicholson's article. The date of publication, as far as I have been able to obtain any information, was about 1830. A.H.]

[2] Stokes, Charles. Notice respecting a piece of recent wood partly petrified by carbonate of lime, with some remarks on fossil woods. Geol. Soc. London, Trans. ser. 2, vol. 5, pp. 207–214, pls. 16, 17. 1840.

At about this same period specimens of fossil invertebrates from Jamaica, and silicified wood from Antigua, were mentioned briefly by Merian[1]; but in regard to the latter he merely remarked that "der grösste Theil sind Hölzer verschiedener Art, im verkieselten Zustande."

The most extensive and critical studies of the fossil woods were by Felix.[2] These were first published in 1882 as a dissertation for a doctorate, in connection with the Faculty of Philosophy of the University of Leipzig. In this publication, on pages 63–78, under the heading "Hölzer aus Antigua," he described the following eleven new species:

Taenioxylon varians, p. 64.
Taenioxylon irregulare, p. 65.
Helicotoxylon speciosum, p. 66, fig. 1.
Helicotoxylon tenerum, p. 67.
Cassioxylon anomalum, p. 69.
Anacardioxylon spondiaeforme, p. 70.
Ebenoxylon diospyroides, p. 71, fig. 3.
Schmideliopsis zirkelii, p. 72.
Zittelia elegans, p. 73, fig. 2.
Palmoxylon kuntzii, p. 77.
Palmoxylon molle, p. 77, fig. 4.

He also, on page 76, renamed *Fasciculites antiguensis* Unger,[3] and listed it as *Palmoxylon antiguense* (Unger).

His second paper, published in 1883, included additional descriptions and further discussion of the Antigua fossil woods. A complete list, with comments, is as follows:

Taenioxylon varians Felix, p. 10, pl. 1, figs. 3, 4.
Taenioxylon irregulare Felix, p. 11, pl. 1, figs. 1, 2.
Taenioxylon multiradiatum,* p. 11, pl. 1, figs. 10, 11; pl. 2, fig. 10.

This genus is referred to the Leguminosae; and, in regard to the species last listed, he remarks: "Diese Art is wahrscheinlich ein Papilionaceen Holz."

[1] Merian, Peter. Naturf. Gesellsch. Basel, Ber. ü. d. Verh. vol. 6, Aug. 1842–July 1844, p. 64. 1844.

[2] Felix, Johannes. (*a*) Studien über fossile Hölzer. Pamph., pp. 1–83, figs. 1–4 on plate not numbered. Leipzig, 1882. (*b*) Die fossilen Hölzer Westindiens. Samml. paleont. abhandl., ser. 1, no. 1, pp. 1–29, pls. 1–5. Cassel, 1883.

[3] Unger, Franz. De palmis fossilibus, *op. cit.*, p. LVIII, pl. 2, figs. 5–7.

Zittelia elegans Felix, p. 14, pl. 2, f. 1, 2.

This genus is included, tentatively, in the Leguminosae.

Cassioxylon anomalum Felix, p. 15, pl. 2, figs. 3, 5.

It is possible that the specimen upon which this species was based may not have come from Antigua. The author states (*loc. cit.*, p. 15) that "der Fundort für dieses Holz . . . ist zwar auf der Etikette nicht angegeben, ich glaube es jedoch seinem ganzen äusseren Habitus nach für ein Holz von Antigua halten zu mussen." The species is compared with the existing species, *Cassia speciosa.*

Schmideliopsis zirkelii Felix, p. 16, pl. 2, figs. 6, 8.

This species is compared with the existing species, *Schmidelia haemorrhoea*, and is relegated, tentatively, to the Sapindaceae.

Anacardioxylon spondiaeforme Felix, p. 16, pl. 2, figs. 7, 9.

This species is compared with the existing species, *Spondias lutea.*

Ebenoxylon diospyroides Felix, p. 17, pl. 4, fig. 6.

This species is compared with the existing species, *Diospyros discolor* and *D. virginiana.*

Helicotoxylon speciosum Felix, p. 18, pl. 3, figs. 2, 8.

Helicotoxylon tenerum Felix, p. 19, pl. 3, figs. 1, 6.

The botanical affinities of this genus are stated to be, probably, with the lianes of the tropics ("Schlingpflanzen" or "*Serjania* Arten") and referable to the Sapindaceae. He also cites (p. 20) Unger's *Hauera americana* (see the present paper, footnote 2, p. 262) and its possible near relationship to *Helicotoxylon.*

Palmoxylon antiguense (Unger) Felix, p. 22, pl. 4, fig. 5.

Palmoxylon kuntzii Felix, p. 22, pl. 4, fig. 5.

Palmoxylon molle Felix, p. 23, pl. 2, fig. 11.

*Palmoxylon quenstedti,** p. 25, pl. 4, fig. 4.

Palmoxylon tenerum Felix, p. 29, pl. 4, fig. 1. (= *Fasciculites palmacites* (Stenzel) Cotta, Die Dendrolithen, etc., pp. 49–50, pl. 9, figs. 1, 2. Dresden, 1832.)

*Rhizopalmoxylon,** p. 27.

No species is described under this genus, which is designated as representing "Wurzeln von Palmen."

The names starred (*) represent new descriptions.

In conclusion the author discusses the possible Upper Cretaceous, but more probably Tertiary age of the species, and remarks upon their close relationship to the existing flora of

the region as evidence that there was little or no difference in climatic conditions between those times and the present.

In 1897 Stenzel[1] described and figured two new species of fossil monocotyledones from the island. The first one, *Palmoxylon iriarteum*, based upon a specimen of wood in the State Museum at Stockholm, he compared with the existing palm genus *Iriartes*. In regard to the second one, *Rhizocaulon antiguense*, he remarked that Herr Leuckart of Chemnitz "hatte es vor etwa 20 Jahren aus der bergakademischen Niederlage in Freiberg erhalten, von dem inzwischen verstorbenen Verwalter derselben, Wapler, als Hornstein von der Insel Antigua bezeichnet." He also discussed its taxonomic position and determined it to be a monocotyledone, related to either the Palmaceae, the Cyperaceae, or the Juncaceae, but did not suggest any definite relationship with any existing genus.

Incidentally it may not be out of place to here record a list of twelve specimens of fossil woods from the island, included in the paleobotanical collections of The New York Botanical Garden, that are designated by the following common names: black willow, guava, manchinil, tamarind, loblolly, breadfruit, mango, ailanthus, red cedar, banana, cabbage palm and needle-eyed cocoa palm. The date of collection and the name of the collector are not given, nor by whom the specimens were identified and named; but accompanying them is a label, worded as follows: "The series of silicified woods numbered 1, 2, 3, &c., and marked in ink on the specimen with the name of some recent wood, as 'Guava,' 'Mangrove,' &c., are from Antigua, W. I. The names given them are quite unreliable." [Signed] "J. S. Newberry."

The latest contribution to the fossil flora of this and certain of the neighboring islands was by Howe,[2] who described and figured several species of fossil calcareous algae which he stated (*loc. cit.*, p. 11) were "collected in February and March 1914,

[1] Stenzel, Gustave. (*a*) Palmoxylon iriarteum n. sp., ein fossiles Palmenholz aus Antigua. K. Svensk. Vetensk.-Akad., Handl. (Beih.) vol. 22, sec. 3, no. 11, pp. 1–18, pls. 1, 2. 1897. (*b*) Rhizocaulon antiguense n. sp. K. Mineral.-Geol. u. Praehist. Mus. Dresden, Mitteil. no. 13, art. 2, pp. 21–24, pl. 3, figs. 22–29. 1897.

[2] Howe, M. A. Tertiary calcareous algae from the islands of St. Bartholomew, Antigua, and Anguilla. Carnegie Inst. Washington, Publ. no. 291, pp. 9–19, pls. 1–6. 1919.

by Dr. T. W. Vaughan, in the Eocene St. Bartholomew limestone of the island of St. Bartholomew, the middle Oligocene Antigua formation of the island of Antigua, and the upper Oligocene Anguilla formation of the island of Anguilla."

Following is a list of the species from Antigua:

Archaeolithothamnium affine n. sp., p. 11, pl. 4, fig. 1; pl. 5.
Lithothamnium concretum n. sp., p. 12, pl. 1, fig. 2; pl. 2.
Lithophyllum (?) *molare*, n. sp., p. 15, pl. 4, figs. 2–4.
Lithoporella melobesioides (Foslie) Foslie, p. 16.

Saint Bartholomew

Two species of coralline algae, from the "Eocene St. Bartholomew limestone" of this island, previously mentioned, were described and figured by Howe [1] in 1919, viz.:

Lithophyllum homogeneum n. sp., p. 14, pl. 1, fig. 1; pl. 3.
Lithoporella melobesioides (Foslie) Foslie, p. 16, pl. 6, fig. 1.

As far as I am aware, these are the only species of fossil plants recorded from the island.

Anguilla

One species of calcareous alga, from the "upper Oligocene Anguilla formation" of this island, previously mentioned, was listed and figured by Howe [2] in 1919, viz.:

Lithoporella melobesioides (Foslie) Foslie, p. 16, pl. 6, fig. 2.

It represents the only paleobotanical record in connection with the island, as far as I have been able to ascertain.

Martinique

Coralline algae, all probably of Miocene age, are apparently the only fossil plant remains recorded from this island. Giraud,[3] in 1902, incidentally noted the occurrence of fragments of *Lithothamnium*, associated with other marine organisms, in calcareous volcanic tuffs, stating that the fragments were particularly abundant in the rocks in the vicinity of Caravelle; and subsequently Lemoine [4] described and figured thirteen new species, as follows:

[1] Howe, M. A. Tertiary calcareous algae, etc., *loc. cit.*

[2] Howe, M. A. Tertiary calcareous algae,. etc, *loc. cit.*

[3] Giraud, Jean. Sur l'âge des formations volcaniques anciennes de la Martinique. Acad. Sci. [Paris], Comp. Rend. Hebdom. Séances, vol. 135, pp. 1377–1379. 1902.

[4] Lemoine, Madame Paul [Marie Dujardin-Baumetz]. Contribution à l'étude des corallinacées fossiles. III. Corallinacées fossiles de la Martinique. Soc. Géol. France, Bull., ser. 4, vol. 17, pp. 256–279, text figs. 1–23. 1917.

Lithothamnium douvillei, p. 258, figs. 1–3.
Lithothamnium caravellense, p. 259, figs. 4, 5.
Lithothamnium peleense, p. 260, fig. 6; p. 268, fig. 16.
Lithothamnium lacroixii, p. 269, figs. 17, 18.
Lithophyllum giraudi, p. 261, fig. 7; p. 271.
Lithophyllum prelichenoides, p. 262, figs. 8, 9; p. 271, fig. 19.
Lithophyllum premoluccense, p. 272, figs. 20, 21.
Lithophyllum martinicense, p. 264, figs. 10, 11.
Lithophyllum (*Dermatolithon*) *preprototypum*, p. 265, fig. 12.
Lithophyllum (*Dermatolithon*) *dublancqui*, p. 274, fig. 22.
Corallina cossmanni, p. 265, figs. 13, 14.
Arthrocardia mangini, p. 266, fig. 15.
Amphiroa prefragilissima, p. 275, fig. 23.

Trinidad

In Wall & Sawkins'[1] report on the geology of Trinidad there is a chapter (Appendix K, pp. 166–178) by Hermann Crüger, Colonial Botanist, with the heading "On some of the vegetable fossils occurring in Trinidad," in which the author mentions "clays, some of which had undergone a considerable change by heat (Porcellanitic shales),[2] while others were not altered in that manner. They contained a great number of impressions of leaves."

Some indefinite descriptions of these leaves are given, such as "a large grass or Cyperaceae"; "a large leaf, generally 4 inches long by $2\frac{1}{2}$ to 3 inches width;" "a narrower leaf, $3\frac{1}{2}$ to 4 inches, by 2 inches;" but in no instance is the description sufficiently definite for identification.

In discussing the silicified woods he says: "The appearance of this wood is very peculiar, and it is not represented by any of the woods of the present creation, as far as I know them, although some, even of this country, make a near approach, such as a few leguminosae; some species of morus, as far as I know them,

[1] Wall, G. P., & Sawkins, J. G. Report on the geology of Trinidad; or Part I of the West Indian Survey. Mem. Geol. Survey [Great Britain and Ireland]. 1860.

[2] *Note*.—These are evidently the deposits mentioned on page 49 (*op. cit.*), viz.: "Strata which will be named *Porcellanite* occur especially at Erin, Points Cedros and Rouge, part of Point Brea, to a small extent at Moruga, and adjaecnt to the large seam of coal at Punta Paloma (Caroni Series)." The baking of the shales, and their alteration into porcellanite by the combustion of included or associated carbonaceous matter is also discussed.

Napoleona, some *Chrysobalaneae*, and a *Proteacea*, and *Rhopala montana*, known to carpenters under the name of aguatapana or beef oak."

His concluding remarks are interesting—almost prophetic, viz.: "They have been coriaceous leaves. . . . As these deposits belong to the Tertiary epoch, since which the conditions influencing vegetation generally have to all appearance not materially changed, we must come to the conclusion that these leaves being principally of the coriaceous kind indicate a vegetation of a truly tropical character. . . . I must express my regret that I have not been able to identify more of the specimens with living plants, or their parts. A little more might have been done in a place where access to museums and scientific libraries can be had, and comparisons instituted with what has been written and collected on the same subject."

Incidentally he also mentions specimens of silicified wood, lignite, "wood apparently in a state of decay," "asphaltum mixed with woody matter," etc. The localities where the red shale with leaf impressions were found are given as "Erin and La Brea"—evidently signifying regional distribution rather than local occurrence.

Geological data are discussed by the authors on pages 35–52, from which the following information may be gleaned. The red shale or porcellanite is mentioned as belonging to the "Caroni or carbonaceous series" of the "Newer Parian Group"; and, further, that "these various strata [Newer Parian group] seem sufficiently related to one another by fossiliferous contents to form one group, of which the organic remains present a certain analogy with the Miocene fauna."

The sequence and correlation of the strata are as follows:

Newer Parian Group.	
Tertiary (Miocene?).....	Moruga or arenaceous series.
	Caroni or carbonaceous series.
	Tamana or calcareous series.
	Naparima marl.
	Nariva series.
Older Parian Group.	
Cretaceous.	

In 1899 Harrison & Jukes-Brown [1] described and discussed the geology of the island and designated the Moruga series of Wall & Sawkins as Pliocene in age. Their final correlation was as follows:

Moruga series	Pleistocene and Pliocene
Naparina marls	Miocene
San Fernando beds [of Guppy] / Nariva series	Oligocene and Eocene

In 1920 a trip was made to the island by Doctor Britton [2] and party, during which the red porcellanite shale was examined, in a quarry near the village of Siparia, in Saint Patrick County, in connection with which Doctor Britton remarked (*loc. cit.*, p. 112): ". . . it is the argillaceous shale porcellanite, quite hard, and contains enormous quantities of fossil leaf impressions and other plant remains. This plant bed is of great extent and thickness. It is exposed in this quarry to a depth of at least sixty feet and is packed with leaf-impressions nearly throughout. Here must certainly exist the key to the ancestry of a large part of the Trinidad flora and the paleontological information to be obtained from an intensive study of the fossils would be of high scientific importance."

A second trip was made the following year,[3] and on this as well as on the previous occasion specimens of fossil plants were collected. The larger number of these were from the quarry at Siparia, and a smaller collection was from arenaceous beds at Moruga, in Victoria County. The several collections have been subjected to critical examination, and a number of selected specimens may be found described and depicted in the descriptive part of the present contribution. The species represented belong, without question, to existing tropical genera, and in many instances they can not be differentiated, on surficial characters

[1] Harrison, J. B., & Jukes-Brown, A. J. The oceanic deposits of Trinidad (British West Indies). Geol. Soc. London, Quart. Journ. vol. 55, pp. 177–189. 1899.

[2] Britton, N. L. A botanical expedition to Trinidad. New York Bot. Gard., Journ. vol. 21, pp. 101–118. 1920.

[3] See Britton, N. L., New York Bot. Gard., Journ. vol. 22, pp. 93–102. 1921.

alone, from existing species. They apparently can not be older than Miocene, and may be as recent as Pliocene in age.[1]

A recently published contribution to the fossil flora of the island was by Howe,[2] in 1922, in which the following two new species of calcareous algae are described and figured:

Lithothamnium pennyi, p. 1, pl. 1, figs. 1–3; pl. 2.

Matchepoorie quarry.

Lithophyllum trinitense, p. 2, pl. 3, figs. 1, 2; pl. 4.

Gasparillo quarry.

Both are regarded as lower Miocene in age.

The most recent published contribution to the fossil flora of the island was by Berry[3], in which may be found described and figured (*loc. cit.* p. 103, fig. 1) a fossil flower under the name *Lecythidoanthus kugleri* gen. et sp. nov., supposed to belong in the Lecythidaceae. The specimen upon which the species was based is described as having been collected by Dr. H. Kugler in "the naturally burnt clay known as porcellanite so common in the Island of Trinidad, probably of late Miocene age." It may be assumed that the type locality was at or in the vicinity of Siparia.

Curaçao

Coralline algae are, apparently, the only fossil plant remains recorded from this island. In 1888 Martin[4] described and figured a new species (*op. cit.*, p. 26, pl. 2, figs. 22–25) under

[1] *Note.*—Professor Gilbert van Ingen of Princeton University, who was one of the party on the second trip, supplied the following memoranda:

"Porcellanite from the Siparia quarry, 3 miles southwest from Siparia village, April 7, 1921. Strike N. 40° W., dip 40° E. Abundant evidence of baking. Collected numerous pieces with leaf impressions, and large piece of silicified wood."

"Plant-bearing clayey sands, in bluff just north of Moruga, on south shore, March 19, 1921. Clay beds alternate with sand and lignitic sand in thin seams. The dip is about 70° S. Faults are numerous and clean cut, with no breccia zones. Several layers hold abundant fossil leaves; but matrix is mostly too friable for preservation. Collected from the better preserved lots and treated them with shellac."

[2] Howe, M. A. Two new Lithothamnieae, calcareous algae, from the lower Miocene of Trinidad, British West Indies. U. S. Nat. Mus., Proc. vol. 62, art. 7, pp. 1–3, pls. 1–4. 1922.

[3] Berry, E. W., A fossil flower from the Miocene of Trinidad. Amer. Jour. Sci., vol. 7, pp. 103–108, text figs. 1, 2. Feb. 1914.

[4] Martin, Karl. Bericht über eine Reise nach Niederländisch West-Indien, etc., pt. 2, Geol. Leiden, 1888.

the name *Lithothamnium curasavicum*, from rocks described as Cretaceous in age; and Kloos,[1] in the following year, in a discussion of the contents of certain calcareous sandstones, mentioned (*loc. cit.*, p. 82) "cylindrischen aeste von Kalkalgen (*Lithothamnium*)."

Porto Rico

As far as I have been able to ascertain, no fossil plant remains were collected on or recorded from Porto Rico previous to 1913, when a scientific survey of the island was inaugurated under the joint support of the New York Academy of Sciences and the Porto Rican Government, with the coöperation of the American Museum of Natural History, Columbia University, and The New York Botanical Garden. A series of seven reports, on various features of the survey, has been published,[2] besides several preliminary papers, notes, etc.

References to fossil plant remains are very few, and one of the earliest was by Hodge,[3] in a paper presented at a meeting of the Section of Geology and Mineralogy of the New York Academy of Sciences, May 15, 1916, in which he remarked (*loc. cit.*, p. 278) that "across the northeastern portion of the area is a broad belt of rock. . . . The presence of *Cladophyllia furcifera* [a species of coral] in a bed of limestone and of fossil leaves in an adjacent hematite bed point, according to Dr. Edward W. Berry and Dr. Frank H. Knowlton, to the Comanchic [Lower Cretaceous] age of these beds."

In a subsequent paper by the same author[4] the subject was treated in a somewhat more extended manner. In discussing an unconformity between two series of sedimentary rocks—the Barranquitas-Cayey and the Sierra de Cayey—he remarked (*loc. cit.*, pp. 192–193) that "a short distance below this unconformable contact two calyxes of a coral were found in a limestone which

[1] Kloos, J. H. Untersuchungen über Gesteine und Mineralien aus West-Indien. Samml. Geol. Reichsm. Leiden, ser. 2, vol. 1, no. 3, pp. 1–110, pls. 1–3. 1889.

[2] New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 1, pts. 1–4. 1919–1922; vol. 2, pt. 1. 1923; vol. 3, pts. 1, 2, 1920, 1921 [misprinted 1920]; vol. 5, pt. 1. 1923.

[3] Hodge, E. T. Geology of the Coamo-Guayama region, Porto Rico [Secretary's abstract]. New York Acad. Sci., Annals vol. 27, pp. 277–278. 1917.

[4] Hodge, E. T. Geology of the Coamo-Guayama district. New York Acad. Sci. Scientific survey of Porto Rico and the Virgin Islands, vol. 1, pt. 2, pp. 111–228. 1920.

have been identified as *Cladophyllia furcifera*. . . . Its presence here should indicate that the rocks are at least of Comanche age. Below the limestone occurs a thin bed of bog iron ore and in it were some leaves. Dr. Edward W. Berry and Dr. F. H. Knowlton identified these leaves as follows:

Nelsonia [*Nilssonia*], an old Mesozoic order of cycads.
Protorhipis, a fern with the same range as above.
Another species of Mesozoic fern.
A dicotyledon.

"The above authorities stated that these plants were not critical for the Comanche, but that they tended to support the evidence of the corals—at least they indicate Mesozoic age."

Fossil coralline algae, represented by thalli of *Lithothamnium*, are mentioned as constituents of the Coamo Springs limestone, and two specimens are shown in cross section (*loc. cit.*, p. 155, fig. 15; p. 156, fig. 16).

During the prosecution of the survey in 1916 Hubbard [1] was engaged in geological work in the Lares District, where he made collections of fossil plant remains at several localities, especially in the vicinity of Lares, on the Guajataca and the Collazo River. The specimens from the localities on the latter river were in the San Sebastian or Collazo shales, and those from the river first mentioned were in the Lares limestone. The best preserved of these specimens have been figured and may be found described in the descriptive part of the present paper.

Those who have studied the stratigraphical relations of the plant-bearing beds in the field are not entirely agreed as to the exact age of the beds. The San Sebastian shales have been regarded as ranging from the upper Eocene to the Middle Oligocene, and the Lares limestone, which overlies the latter, as slightly younger. Numerous correlation tables may be found in the publications cited. For ready reference, however, the following sequence of formation, series, and group names is here given:

[1] Hubbard, Bela. The geology of the Lares district, Porto Rico. *Idem*, vol. 2, pt. 1, pp. 1–115. 1923. Tertiary mollusca from the Lares district, Porto Rico. *Idem*, vol. 3, pt. 2, pp. 79–164. 1921.

Post-Tertiary	Santa Isabel formation and San Juan formation	
Tertiary	Los Puertos limestone Quebradillas limestone Cibao limestone Lares limestone	= Arecibo group or formation, and Pepino formation. (Oligocene?)
	San Sebastian, or Collazo, or Lares shales. (Oligocene or U. Eocene?)	
	Rio Descalabrado series Coamo Springs formation Rio Jueyes series	= Eocene?
Cretaceous	Guayama series Sierra de Cayey series	= L. Cretaceous?
	Barranquitas-Cayey series Rio de la Plata series	= L. Cretaceous (Comanche?)

Hispaniola [1]

Republic of Santo Domingo

In 1871, 1873, and 1881, Gabb [2] published the results of his geological investigations during the years 1868–1871 in the Dominican Republic.

[1] This island is more generally known either as Santo Domingo or as Haiti, and on most modern maps it is designated by one or the other of these names, or else by both; but the use of either one for the island as a whole, especially on labels and in descriptive text, is liable to lead to misinterpretation, and more or less confusion of locality in connection with the two republics between which the island is divided. There is also a town of Santo Domingo in the Dominican Republic and another of the same name in Cuba, and the island of Dominica—one of the Leeward Islands of the British West Indies. It has, therefore, been deemed advisable to designate the island as a whole by its original name, Hispaniola—the Latinized equivalent of the old Spanish name, Española—and to limit the use of the names Santo Domingo and Haiti to the two political divisions of the island.

[2] Gabb, W. M. Notes on the geology of Santo Domingo. Amer. Journ. Sci., ser. 3, vol. 1, pp. 252–255. 1871.

In the American Journal of Science (*loc. cit.*, p. 254) he discusses the Tertiary strata and says: "They consist of conglomerates, sandstones, gray, blue, brown, and white shales, argillaceous and pure limestones, the rocks being enumerated in an ascending series from the conglomerates upward. . . . There have been enough fossils found in all the beds, from base to top, to settle the question, that no line of demarkation of age can be drawn in the series. The species have not been sufficiently studied, by me, to enable me to express a positive opinion as to the part of the Tertiary group to which they belong. Messrs. Geo. Sowerby and J. Carrick Moore (Quart. Jour. Geol. Soc., London, 1849, p. 129) consider them, for good reasons given, to be Miocene, in which opinion I am inclined to concur; while Mr. T. A. Conrad, whose acquaintance with the American Tertiaries is greater than that of any other person, says they are Oligocene."

In the Proceedings of the American Philosophical Society[1] (*loc. cit.*, p. 571), in the secretary's abstract of Gabb's remarks at the meeting held November 15, 1872, it is stated that "the San Domingo Miocene holds 217 extinct and 97 living forms (mollusca)," and that "vertebrate remains (*Carcharodon*, *Megalodon* and other well-known Miocene species) also occur with them." Subsequently, in the Transactions of the same society (*loc. cit.*) his previous publications were elaborated and extended, and were included in a final report on the subject. From this report the following items are abstracted:

On page 97 he says: "Shortly after the appearance of the joint paper by Moore and Sowerby, Mr. Conrad published a short note, having more particular reference to the Vicksburg deposit in Mississippi, asserting that he found an 'analogy,' and even adding 'whether all the forms in this group in St. Domingo are *synchronous* remains to be proved.' . . . He claims to have identified three species as occurring in the two regions. . . . My own comparison of specimens completely disproves this. . . . But I have found a single species in common—his *Ficus Mississippiensis*. . . ."[2]

[1] On the topography and geology of Santo Domingo. Amer. Philos. Soc., Proc. 1871–72, vol. 12, pp. 571–573. 1873. *Idem*, Trans. vol. 15, II. ser., art. 4, pp. 49–259, with geological map. 1881.

[2] *Note.*—This is, without doubt, a misprint for *Fusus mississippiensis* Conrad—a Tertiary molluscan species of the region. The name *Ficus mississippiensis*

On page 97 he mentions an installment of fossils, sent by Mr. Hencken to London in 1849, in which was included "dicotyledonous wood." On page 99 is given the following correlation table, of Robert Etheridge:

Middle Tertiary series of Santo Domingo	Later or Upper Miocene.
Middle Tertiary series of Cuba	
Middle Tertiary series of Cumana	
Caroni series of Trinidad	
Miocene series of Jamaica	
Chert formation of Antigua	Older or Lower Miocene.
Anguilla beds	
San Fernando beds, Trinidad	

On pages 149–150 he describes conglomerate rocks at the Angostura [narrows] of the Yaqui del Norte River, near Santiago, and says that they are "made up of rounded pebbles, broken shells and containing much fossilized wood, sometimes showing tubes of teredos."

The author's references to fossil plant remains were in every instance very brief and casual. He collected a few specimens of fossil leaves, however, which were apparently sent to Dr. J. S. Newberry, at that time Professor of Geology and Paleontology at Columbia College, as I infer from the recent discovery of a small collection, now in the Museum of The New York Botanical Garden, accompanied by a label in Professor Newberry's handwriting, which reads: "Fossil Plants, Miocene (with 33 per ct. living species of molluscs & incl. Carcharodon and Megalodon). Cibao Valley, St. Domingo. Gabb." A comparison of the wording of this label with the abstract of Gabb's remarks previously quoted leaves but little doubt that these specimens represent material collected by Gabb. The collection includes

Conrad has, however, been cited occasionally, in connection with paleobotanical records, and more or less confusion has resulted in consequence. The obvious error should not be perpetuated, and should be corrected wherever feasible. The synonymy of the latter binomial is as follows:

Ficus mississippiensis (Lesquereux) Berry, U. S. Geol. Survey, Prof. Paper 131-A, p. 9, pl. 6, figs. 1, 2; pl. 7; pl. 8. 1922. = *Cinnamomum mississippiensis* Lesquereux, Amer. Philos. Soc., Trans. vol. 13, art. 14, p. 418, pl. 19, fig. 2. 1867. Not *Ficus mississippiensis* Conrad, *fide* Gabb, Amer. Philos. Soc., Trans. vol. 15, II. ser., art. 4, p. 97. 1881. = error for *Fusus mississippiensis* Conrad. A. H.

only seven specimens, but they are fairly well preserved, in a matrix of indurated yellowish-gray clay, and all are described and figured in the descriptive part of the present paper.

It was not until nearly half a century later that anything appears to have been published, or recorded, in relation to the fossil flora. In 1917 Maury [1] incidentally referred to the presence of fossil plant remains at Los Quernados, on the Rio Gurabo. In a description of the geological section at this locality (*loc. cit.*) the following item is included: "Flora of Zone B. The top of Zone B contains wood and leaves of the Myrtle, Laurel and Mimosa families. Professor E. W. Berry was so kind as to identify them generically for me. . . . The genera represented are *Eugenia, Nectandra* and *Inga*"; and these specimens are again referred to by the same author in a subsequent publication,[2] as follows: "Looking back to early Miocene times we may picture to ourselves an arm of the sea running east and west in the northern part of Santo Domingo and occupying what is now the valley of the Rio Yaqui. . . . Lignitic beds, gravels, and clays were being deposited. . . . Members of the Myrtle, Laurel, and Mimosa families grew upon the neighboring shores, with a number of woods of new species not known from elsewhere."

In 1919 a geological reconnaissance of Santo Domingo was made by Vaughan and others,[3] and during its prosecution fossil plants were collected at several localities. These were submitted to and were described by Professor Berry [4] of Johns Hopkins University, by whom ten new species were described and figured and three specimens were identified generically, as follows:

Poacites sp., p. 118.
Pisonia conditi, p. 119, pl. 21, fig. 1.
Inga sanchezensis, p. 120, pl. 21, fig. 11.
Inga sp., p. 117.

[1] Maury, Carlotta J. Santo Domingo type sections and fossils, part 2, stratigraphy. Amer. Paleontol., Bull. vol. 5, no. 30, p. 435 (19). 1917.

[2] Maury, Carlotta J. Santo Domingo paleontological explorations. Journ. Geol., vol. 26, no. 3, pp. 226–227. 1918.

[3] Vaughan, T. W., Cooke, Wythe, Condit, D. D., Ross, C. P., Woodring, W. P., and Calkins, F. C. A geological reconnaissance of the Dominican Republic. Geol. Survey Dominican Republic, Mem., vol. 1. Prepared by the U. S. Geol. Survey, Washington, 1921.

[4] Berry, E. W. Tertiary fossil plants from the Dominican Republic. U. S. Nat. Mus., Proc. vol. 59, pp. 117–127, pl. 21. 1921.

Pithecolobium samanensis, p. 120, pl. 21, fig. 2.
Sophora cookei, p. 121, pl. 21, fig. 12.
Sapindus hispaniolana, p. 122, pl. 21, fig. 3.
Calyptranthes domingensis, p. 122, pl. 21, figs. 9, 10.
Bucida sanchezensis, p. 123, pl. 21, fig. 8.
Melastomites domingensis, p. 124, pl. 21, fig. 7.
Melastomites sp., pp. 117, 124.
Bumelia reclinatafolia, p. 125, pl. 21, fig. 4.
Guettarda cookei, p. 125, pl. 21, figs. 5, 6.

In the introduction the author briefly discusses the stratigraphic relations of the flora, and remarks, on page 117: "The number of forms identified is . . . much too small . . . to give a correct idea of the botanical facies or of the geological age beyond the obvious facts that they indicate a tropical habitat and a Tertiary age."

In the memoir by Vaughan and others, previously mentioned, Berry's identifications are included in tables of distribution, stratigraphic discussions, etc. The plant-bearing beds in the vicinity of Sanchez, Province of Samana, from which all but two of the specimens described by Berry were collected, are designated (*loc. cit.*, pp. 76 and 165) as "Miocene or Pliocene," and are included in the Yaqui Group as defined by Cooke on pages 65–66. One of the two excepted specimens (*Melastomites* sp.), collected on the Gurabo River, about $5\frac{1}{2}$ miles from Gurabo Adentro, in the Province of Monte Cristi, is listed as referable to the Cercado Formation of the Yaqui Group, and the other one (*Sophora cookei* Berry), collected on the San Juan River, in the vicinity of Los Bancos, Azua Province, is listed, on page 109, as occurring in beds of Middle Oligocene age.

Exactly where the specimens collected by Gabb were found was, apparently, not recorded, otherwise than by the general designation "Cibao Valley"; but the lithological characters of the matrix indicate that it is similar to that in which the specimens from the vicinity of Sanchez are contained, which is described as a yellowish sandy clay, and this locality is within the topographic limits of the Cibao Valley region. It appears probable, therefore, that Gabb's specimens came from beds on the north shore of Samana bay, in the vicinity of Sanchez.

The stratigraphic relations of the plant-bearing beds, according to tentative expressions of opinion by those who have studied them, may be tabulated as follows:

Bluff on Samana Bay, about 1½ miles east of Sanchez, Province of Samana. (Late Tertiary or Pleistocene, *fide* Berry.)	(Miocene or Pliocene, *fide* Vaughan *et al.*)	Mao clay
		Mao Adentro limestone
Cut in clay near pier at Sanchez. Beach, 400 feet east of latter locality.	Yaqué Group	Gurabo formation
Rio Gurabo, about 5½ miles up from Gurabo Adentro, Province of Monte Cristi. (Cercado formation, *fide* Vaughan *et al.*)		Cercado formation
Rio Gurabo in the vicinity of Los Quernados. (Early Miocene, *fide* Maury.)		Baitoa formation
Rio San Juan, about 1 mile west of Los Bancos, Province of Azua. (Middle Oligocene, *fide* Vaughan *et al.*)		Bulla conglomerate

Republic of Haiti

The geological investigations by Vaughan and others in the Dominican Republic were extended into the Republic of Haiti. Fossil plant remains were collected at a number of localities, some of which collections yielded specimens that were sufficiently well preserved to be differentiated and described. These were made the subject of a paper by Berry,[1] in which the following seven new species were described.

Chara woodringi, p. 3, text figs. 1*a–c*.
Gymnogramme woodringi, p. 4, pl. 1, figs. 1–4.
Simaruba haitensis, p. 6, pl. 1, fig. 8.
Mespilodaphne hispaniolana, p. 7, pl. 1, fig. 11.
Mimusops praeparvifolia, p. 8, pl. 1, fig. 10.
Chrysophyllum cahobasensis, p. 8, pl. 1, fig. 9.
Bumelia cuneatafolia, p. 9, pl. 1, figs. 6, 7.

Incidentally he also identified two previously described species (*Pisonia conditi* Berry, and *Guettarda cookei* Berry) from the Dominican Republic, and mentions "fragments of dicotyledonous leaves, probably representing the genus *Ficus* . . . fragments of

[1] Berry, E. W. Tertiary fossil plants from the Republic of Haiti. U. S. Nat. Mus., Proc. vol. 62, art. 14, pp. 1–10, pl. 1 and figs. 1, 2 in text. 1922.

what appear to be a species of *Terminalia*, a palm ray, and fragments of six or eight species of dicotyledons," and "fragments of lauraceous leaves suggesting the genus *Nectandra*. . . ."

Fossil plant remains were collected at a number of localities, and in beds regarded, respectively, as Cretaceous, Tertiary (Eocene and Miocene), and Pleistocene in age; but all of the specimens that were described and identified were referred by Berry to the Miocene ("Artibonite group"), apparently equivalent to the Maissade beds of Jones [1] (*loc. cit.*, p. 744).

Jamaica

In a report on the geology of Jamaica by Sawkins and others,[2] in 1869, there are a few incidental references to fossil plant remains, in connection with a geological section depicted on the first of two unnumbered plates at the end of the volume. On this plate, opposite the designation "Eocene. Black shale" is the legend "greenish brown & black laminated Shale, interstratified with thin beds of fine grained Sandstone, contain.g. fossil stems and some Lignite"; and opposite "Eocene. Trappean series" is "variegated & mottled Clay & friable Conglomerate contain.g. Agates and silicified Wood." This is the only reference that I have been able to obtain in relation to the fossil flora of the island.

Cuba

The earliest references to fossil plant remains in Cuba were, apparently, in two papers by Felix,[3] in 1882 and 1883.

In the publication first cited, on page 78, under the heading "Holz aus Cuba," he listed *Palmoxylon cottae* [= *Fasciculites cottae* Unger]; but in the publication last cited (p. 24, pl. 5, fig. 2) he described and figured a new species, *Palmoxylon integrum*, which he stated was based upon the same specimen that he originally identified as *P. cottae*. The species *Palmoxylon integrum* Felix should, therefore, be substituted for *P. cottae* (Unger) Felix as an element in the fossil flora of Cuba.

As far as I am aware only two other contributions to the fossil flora of Cuba were subsequently published. Specimens of

[1] Jones, W. F. A geological reconnaissance in Haiti. Journ. Geol., vol. 26, pp. 728–752. 1918.

[2] Sawkins, J. G., and others. Reports on the geology of Jamaica; or Part II of the West Indian Survey. 1869.

[3] Felix, Johannes. *Loc. cit.*, see the present paper, p. 264.

fossil wood were collected in the Province of Camaguey (Puerto Principe) and were discussed by Galtés [1] in 1911. All were identified as and were referred to living species, natives of the island.

The unique method employed in the study of the material and in the identifications of the species is described on pages 193–195, under the caption "Clasificación y Descripción de los Fósiles," a free translation of which is as follows: [2]

"Great are the difficulties which present themselves when one attempts to distribute in their respective groups those organisms which lack the principal characters which contribute the fundamentals of the classification of phytology. Trunks and branches, and in some cases a few roots is all that I have been able to find among the numerous examples which have been encountered on the Chorrillo. The leaves, flowers and fruits so necessary for verifying the desired classification either do not exist in that locality, or at the time that we were there we did not have the good fortune to find them.

"With my desire to know and classify the fossils that I had found I acquired many examples of the trunks of various [living] plants of varying sizes and ages and compared the colors with those of the fossils and the texture, whether compact or fibrous; the bark, when it existed, and other particulars, not forgetting those that sometimes pass without alteration from the living to the fossil plant. In other cases there exist those characters which have been more or less modified, increasing the difficulties of recognition which in some cases I have been able to discern in spite of the alterations.

"Being perplexed one day over certain specimens, the idea occurred to me to test the specific gravity, as a guide in this investigation. My reasoning was as follows: Although all the fossils found on the Chorrillo are silicified, in the substitution of the organic by the siliceous molecule they should preserve among themselves the same relation that they had in each [living] species, which differ in relative density and hence in specific gravity; but this difference, in general, would be less than when

[1] Galtés, Pio. Memoria sobre unos fosiles vegetales encontrados en el Chorrillo (Puerto Principe). Univ. Habana, Revista de la Facultad Letras y Ciencias, vol. 12, pp. 189–209. 1911.

[2] I am indebted to Mrs. N. L. (Elizabeth G.) Britton for the translation.

silicified. I then searched for the specific gravity of various known [fossil] woods which were well known, such as the Arabo [*Erythroxylum*], the Ébano [*Diospyros*] and the Dagame [*Calycophyllum*], finding in each case a different specific gravity, and that it is greater or less according to density of the respective wood or timber, although the relative proportions are not the same. The numbers that I found for the preceding species are as follows:

Arabo	— 2.611
Ébano	— 2.562
Dagame	— 2.500

Numbers which are inferior to that of silica which, as is well known, is 2.65. I have a table of the specific gravities of various [living] Cuban woods, compiled by Dr. Eugenio de Coloma, and I find that the specific weights of the species above numerated are respectively 1.53, 1.20, and 0.90, numbers which are not proportionate to those which I found in the fossil specimens, but which bear a certain relation to each other. I later determined the specific weights of all the specimens that I had in the collection and, on reflecting on my results, which as will be seen are not as satisfactory as I hoped, I am persuaded that the relation cannot be perfect, as in verifying *Epigenia* [1] I found that the plant varied in diverse circumstances which modified the disposition of the mineral molecules and produced, in consequence, an alteration more or less evident in the specific weight.

"If it had been possible for me to make a microscopic examination of the fossils, perhaps the data which this would have supplied, in combination with the microscopic studies which are being made of plant fibres, it would have facilitated a more intimate and perfect knowledge of the true place of each of the fossils in a paleophytologic classification than the one that I have presented. But I lack the means to be able to verify them.

"These observations will indicate to men of science that in undertaking this work I have not ignored, nor for one moment failed to recognize, the difficulties with which I have had to battle, and I am very far from having the presumption to believe that I have ascertained it all! My work is simply one stone, perhaps the least important, in the vast edifice of the phytopaleontology

[1] *Eipgenia* (?). Not found in dictionary. E. G. B.

of Cuba. The only value of my little stone is that it is the first. Perhaps the Almighty will not let it be the only one in the great field of Cuba!

"I have followed the classification of De Candolle, dividing all the fossils into Dicots and Monocots, and have not found any Acotyledons!

"The Dicotyledons are divided into four classes:

Talamifloras.
Calicifloras.
Corolifloras.
Monoclamideas."

A tabulated list of the species identified, with their common names, is given on page 209. The number of species is 57, included in 49 genera and 25 families. Fifty-one of the species belong to the Dicotyledonae and six to the Monocotyledonae. The list of species, with certain orthographic interpolations, is as follows:

Curatella americana
Capparis jamaicensis
Casearia ramiflora
Casearia alba
Casearia spinescens
Eritrophilum oboxatum [= "Arabo." *Erythroxylum obovatum*]
Ibiscus taliascens [= *Hibiscus tiliaceus*]
Pavonia spinifex
Carolinea princeps
Guazuma tomentosa
Sapindus saponaria
Ratonia apetala
Guaria trichiloides [= *Guarea trichilioides*]
Trichilia spondioides
Swietonia mahogoni [= *Swietenia mahogani*]
Xantoxillum juglandifolium [= *Zanthoxylum juglandifolium*]
Xantoxillum caribeum [= *Zanthoxylum caribaeum*]
Spondia graveolens [= *Spondias graveolens*]
Rhus metopium
Belaria mucronata [= *Belairia mucronata*]
Copaifera himenefolia [= *C. hymenaefolia*]
Lisiloma sabicu [= *Lysiloma sabicu*]

Poeppigia procera
Lonchocarpus latifolius
Andira inermis
Bucida angustifolia
Bucida capitata
Chicharrona intermedia [= *Chicharronia intermedia*]
Calophillum candidisimum [= "Dagame." *Calycophyllum candidissimum*]
Gonipa americana [= *Genipa americana*]
Mimusops balata
Sideroxilon salicifolia [= *Sideroxylon salicifolium*]
Sideroxilon palidum [= *S. pallidum*]
Sideroxilon masticodendron [= *S. mastichodendron*]
Brumelia nigra [= *Bumelia nigra*]
Diospiros tetrasperma [= "Ebano." *Diospyros tetrasperma*]
Comeraria latifolia [= *Cameraria latifolia*]
Jacaranda cerulea [= *J. caerulea*]
Tecona penthaphila [= *Tecoma pentaphylla*]
Cordia rotundifolia
Cordia gerancastus [= *C. geraschanthus*]
Erhetia tinifolia [= *Ehretia tinifolia*]
Borreria calofila [= *Bourreria calophylla*]
Dripetes glauca [= *Drypetes glauca*]
Excecaria lucida [= *Excoecaria lucida*]
Croton lucidus
Dafnosis guacacoa [= *Daphnopsis guacacoa*]
Cecropia obtusa
Celtis trinervia
Trophis americana
Morus tintorea [= *M. tinctoria*]
Oreodoxa regia
Colpotrinax wrightii [= *Colpothrinax wrightii*]
Cocos nucifera
Cocos crispa
Sabal umbraculifera [= *S. umbraculiferum*]
Copernicia wrightii

Any comment upon or criticism of the probable accuracy or inaccuracy of the identifications would not be in place here. A careful examination of the individual specimens upon which the identifications were based would be necessary in order to

ascertain facts upon which to form an opinion of any value on the subject.

In Maza & Roig's [1] Flora of Cuba, pages 11–15, there is a section with the heading "Flora Fosil," in which Galtés' tabulation is quoted in full, with many corrections, and this is succeeded by the concluding paragraph of the section, of which the following free translation also has been kindly supplied by Mrs. Britton:

"Furthermore, Maza has determined a fossil seed of one of the Leguminosae, *Mucuna urens* DC., or 'Ox-eye,' found near Havana, in a calcareous madreporic formation called '*Bazar limestone*,' as well as other plant fossils, which were not determined. But the question is—were they really fossils, were they correctly determined, and to what era do they belong? In this as in so many other things there is much to be done in Cuba."

In 1918 Padres León and Roca collected specimens of fossil leaves at two localities in the Province of Santa Clara and at one in Matanzas, in calcareous tufa, fine indurated clay, and soft incoherent sandstone—all apparently representing deposits of very recent geologic age. The specimens were sent to The New York Botanical Garden, and such of them as were identifiable may be found described and figured in the descriptive part of the present paper.

DESCRIPTIONS OF SPECIES

MONOCOTYLEDONAE

FAMILY PALMAE (Arecaceae)

Genus PALMOPHYLLUM Conwentz

PALMOPHYLLUM sp.

Plate 9, Figure 1

This specimen almost certainly represents a fragment of a palm leaf, but to attempt, definitely, to identify it with any existing genus, or with any described fossil species, would not be warranted, in view of its meagre and imperfectly preserved characters. The nervation is obscurely defined, apparently consisting of a series of relatively strong, parallel nerves, with finer ones in between; and, it is possible that a midrib is represented

[1] Maza, M. G., & Roig, J. T. Flora de Cuba. Rep. Cuba, Secretaria Agric., Com. y Trab., Estación Exp. Agronóm., Bull. no. 22. Habana, 1914.

by the left hand outline of our figure, but this is not a certainty.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Palmophyllum sp. (fragment of petiole)?

Plate 9, Figure 2

This specimen apparently represents a fragment of a finely striated, monocotyledonous petiole, or stem, or organ of some such nature; and as it was found associated with the leaf fragment last described I have ventured to include it, tentatively, in the same genus.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Genus Palmocarpon Lesquereux

Palmocarpon bactrioides n. sp.

Plate 1, Figure 4

Fruits represented by two rounded, irregularly ellipsoidal, nut-like organisms, each about 1.75 centimeters in length by 1.25 centimeters in maximum width, attached at their bases to a common support, partly encompassed by a disrupted, distorted annulus, and marked surficially by fine longitudinal striations and intermediate elongated reticulations.

Apparently this specimen represents two contiguous fruits of a palm, closely resembling those of the existing genus *Bactris*—especially the species *B. acanthophylla* Mart.—with the soft, outer integument or exocarp removed, exposing the hard, nut-like endocarp within. The portion of our specimen that I have designated as an "annulus" I infer to represent the remains or the impression of the original exocarp.

Somewhat similar fossil fruits, from the Tertiary of Chile, were described and figured by Engelhardt,[1] under the name *Carpolithes guilielmoides*, which he compared with the fruit of the existing species *Guilielma* [*Bactris*] *speciosa* Karst.; but this comparison does not appear to be as impressive or quite as satisfactory as is the comparison made in connection with our specimen.

Another fossil species that simulates ours somewhat more closely, from the Tertiary (Fort Union group) of Dakota, was

[1] Engelhardt, Hermann. Über tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, no. 4, p. 686, pl. 1, figs. 5a–c. 1891.

described and figured by Newberry [1] under the name *Carpolithes lineatus*, but without any comment in regard to its probably botanical affinities.

Other fossil species that appear to be more or less similar to ours are *Palmocarpon corrugatum* Lesquereux [2] and *P.* (?) *globosum* Lesquereux,[3] from lower and middle Tertiary horizons, respectively, in Colorado. The latter species he compared, tentatively, with "*Carpites lineatus*?, Newby." [= *Carpolithes lineatus* Newberry, previously mentioned], under which name he had described and figured certain specimens from the Eocene Tertiary of Wyoming.[4] In none of these figures, however, are the surface markings depicted as clearly as they appear on our specimen—especially in connection with the fine reticulations.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Palmocarpon acrocomioides n. sp.

Plate 13, Figure 4

This specimen apparently represents what was, originally, a spheroidal fruit of some kind, with a hard, brittle exterior. In the process of fossilization it was flattened and the exterior was cracked and broken, so that the specimen now presents the appearance of an oblate spheroid, about 3.4 centimeters in diameter, surficially traversed in all directions by fine broken lines that join and cross each other and form a meshwork over the surface that simulates an irregular, brecciated pavement.

That the specimen represents a palm fruit appears to be a reasonable inference, and it may be more or less satisfactorily compared with fruit of certain species in the existing genus *Acrocomia—A. aculeata* Lodd for example—which, when subjected to pressure, so as to become flattened and fractured, presents a very close resemblance to the fossil.

Specimens that are more or less suggestive of ours, from a probable lower Tertiary horizon in Colorado, were described

[1] Newberry, J. S. The later extinct floras of North America. U. S. Geol. Survey, Mon. vol. 35, p. 138, pl. 40, fig. 1. 1898.

[2] Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (Tertiary flora), p. 121, pl. 11, figs. 10, 11 [especially the latter figure]. 1878.

[3] *Idem*, vol. 8 (Cretaceous and Tertiary floras), p. 144, pl. 24, fig. 3. 1883.

[4] U. S. Geol. Surv. Terr., Rept. vol. 7 (Tertiary flora), p. 302, pl. 60, figs. 1 in part, 1*b*–1*d*. 1878.

and figured by Lesquereux[1] under the name *Palmocarpon truncatum* var. *major*. Both the species and the variety appear to differ from our specimen mostly in the smaller size of their fruit.

Also other similar specimens, from the Miocene Tertiary of Switzerland, were described and figured by Heer[2] under the name *Palmacites martii*.

Locality and collector: Hispaniola. Cibao valley, Santo Domingo. Gabb, 1868.

Family Musaceae

Genus Musophyllum Goeppert

Musophyllum trinitense n. sp.

Plate 1, Figure 2

Leaf of unknown shape and dimensions, but apparently not less than 2 decimeters in length by 1.5 decimeters in maximum width; nervation simply pinnate, consisting of a prominent midrib and a double series of fine, parallel secondary nerves, obscurely differentiated in thickness, the relatively coarser ones about 3–4 millimeters distant from each other, the others in between, all diverging from the midrib at obtuse angles in the lower part of the leaf and at more acute angles in the upper part, curving slightly upward and approaching each other toward their extremities.

This specimen, although fragmentary, has so close a superficial resemblance to leaves of the existing genus *Musa* that I would have but little hesitation in so referring it were it not for the doubt that is generally entertained, and the uncertainty that obtains, in regard to the New World nativity of the genus. That our specimen belongs in the Musaceae, however, appears to be reasonably certain, and the generic name accepted for it may be taken to imply inclusion in the Musaceae, but not necessarily in the genus *Musa*. Similar fossil remains, from Tertiary horizons elsewhere, have been described under the fossil genus *Musophyllum*,[3] and others under *Zingiberites*,[4] and it is

[1] Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (Tertiary flora), p. 120, pl. 11, figs. 6–9. 1878.

[2] Heer, Oswald. Flora Tertiaria Helvetiae, vol. 1, p. 97, pl. 41, figs. 2–4. 1855.

[3] *Musophyllum axonensis* Watelet. Description des plantes fossiles du bassin de Paris, text p. 75, atlas p. 8, pl. 17, figs. 1, 2. 1866.

M. complicatum Lesquereux. U. S. Geol. Survey Terr., Rept. vol. 7 (Tertiary flora), p. 96, pl. 15, figs. 1–6. 1878.

[4] *Zingiberites multinervis* Heer. Flora tertiaria Helvetiae, vol. 3, p. 172, pl. 148, figs. 13–15 b. 1859.

Z. dubius Lesquereux. U. S. Geol. Survey Terr., Rept. vol. 7 (Tertiary flora), p. 95, pl. 16, fig. 1. 1878.

more or less difficult to differentiate between them. The resemblance between leaves of certain existing genera in the Musaceae, Zingiberaceae, and Marantaceae is very close, and in many herbarium specimens it is exceedingly difficult to identify the genus, or even the family, from the leaves alone. The critical characters of the secondary nervation, which are essential for identification and differentiation, vary considerably, according to the age of the leaves, and these characters are more obscurely defined in the fossils than in the leaves of existing plants, so that positive identification can not be expected, especially in connection with specimens that are fragmentary and show merely an indication of their original form and dimensions. This phase of the subject was discussed by Berry,[1] in connection with a specimen similar to ours, from the Tertiary of Venezuela (*loc. cit.*, pp. 560–562, text fig. 1), which he referred to *Musophyllum elegans* Engelhardt,[2] from the Tertiary of Colombia, but changed the generic name to *Heliconia* and remarked (*loc. cit.*): "Aside from the actual resemblance between these fossil American forms and the existing *Heliconias*, it seems to me that general considerations point to the conclusion that the genus *Musa* was never present in the Western Hemisphere [in Tertiary time], despite the fact that it flourishes so greatly under cultivation in the American Tropics at the present time." Engelhardt, also, was evidently in doubt in regard to the generic affinities of his specimens, and discussed them in the following words (*loc. cit.*, pp. 25–26): "Die Stücke entstammen jedenfals einer Art der Gattung *Heliconia* L., welche Südamerika eigenthümlich ist, wenigstens liefs sich aus der Nervatur trotz vieler Vergleichungen nicht nachwiesen, ob sie zu dieser oder zu *Musa* L. zu rechnen sei, weshalb ich mich der provisorischen Bezeichnung bediente."

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

[1] Berry, E. W. Tertiary fossil plants from Venezuela. U. S. Nat. Mus., Proc. vol. 59, pp. 553–579, pls. 107–109 and text figs. 1–4. 1921.

[2] Englehardt, Hermann. Über neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 25, pl. 4, figs. 1–3; pl. 5, fig. 1. 1895.

Musophyllum sp.

Plate 14, Figure 2

This specimen apparently belongs to the same genus, and possibly to the same species, as the one last described; but it is too imperfect a fragment for satisfactory comparison.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Monocotyledone of uncertain systematic affinities

Plate 1, Figure 3

Foliaceous organ of unknown shape and dimensions; nervation parallel, consisting of a series of relatively conspicuous nerves, about 3 millimeters distant from each other, and a series of finer, obscurely defined intermediate nerves, parallel with the latter, both series connected by a system of fine, irregularly disposed, closely spaced cross-nervation.

Fragmentary remains of similar appearance to our specimen, from Tertiary horizons both in the Old World and in America, have been described under the genus *Typha;*[1] others under the genera *Sparganium*[2] and *Cyperus;*[3] and, more recently, under the fossil genus *Pontederites.*[4] The latter, at least, I am inclined to regard as possibly morphologically identical with our specimen, but not as related to *Pontederia.* In Knowlton's figure, if my interpretation is correct, the apical part of the specimen is represented, and in ours a portion of the basal or median part. It is impossible, however, by reason of the fragmentary nature of the latter to determine if, in its entirety, it was elongated and grass-like, or if it was laterally expanded; but a relatively broad foliaceous organ appears to be indicated, and the absence of any indication of a midrib is significant.

[1] *Typha latissima* Al. Braun. Heer, Flora tertiaria Helvetiae, vol. 1, p. 98, pl. 43, figs. 1a–7; pl. 44, figs. 1a–3c. 1855.

Lesquereux, U. S. Geol. Survey Terr., Rept. vol. 8 (Cretaceous and Tertiary floras), p. 141, pl. 23, figs. 4, 4*a*. 1883. Etc.

[2] *Sparganium latum* Weber. Paleontographica, vol. 2, p. 157, pl. 18, figs. 6a, 6b. 1852. Etc.

[3] *Cyperus braunianus* Heer. Flora tertiaria Helvetiae, vol. 1, p. 72, pl. 22, fig. 6; pl. 27, figs. 4–7. 1855. *Idem*, vol. 2, p. 163, pl. 147, figs. 8, 9 [especially the latter figure]. 1859.

C. chavannesi Heer. *Idem*, vol. 1, p. 72, pl. 22, fig. 7; pl. 28, figs. 1a–1i.

[4] *Pontederites hesperia* Knowlton. Revision of the flora of the Green River formation, etc. U. S. Geol. Survery, Prof. Paper 131-F, p. 154, pl. 36, fig. 6. 1923.

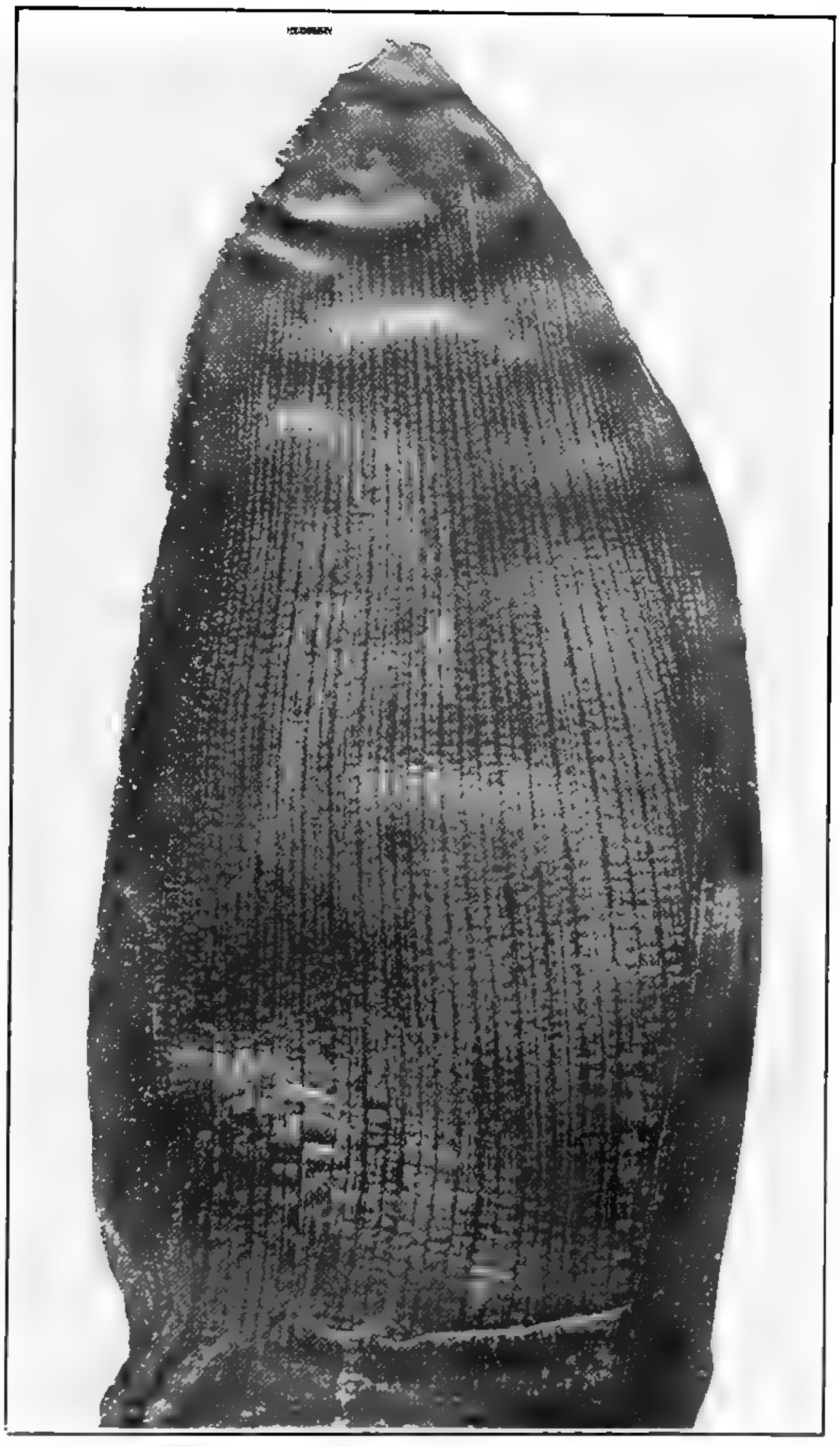


FIGURE 1. Photograph of the upper part of a floral bract of *Musa cavendishi* Lamb, natural size.

If it would be justifiable to infer that the genus *Musa* was an element in the Tertiary flora of America, I would feel strongly inclined to consider our specimen as representing the fragmentary remains of a floral bract referable to that genus. The characters of the nervation in our specimen appear to resemble those of a bract of *Musa* more closely than they do those of any other foliaceous parts of plants with which I have sought to compare it[1]; although somewhat suggestive comparisons were made in connection with certain palm leaves (*Scheelea insignis* Karst., from the island of Tobago), and with leaves of *Diplasia karataefolia* L. C. Rich., a cyperaceous species native on the island of Trinidad, both of which possess the characteristic cross nervation, but not as well defined as in connection with the bract of *Musa.*

In the circumstances I have deemed it best to list our specimen merely as representing fragmentary remains of an unidentified monocotyledone, pending the possible future discovery of a specimen or specimens sufficiently well preserved for the identification of its systematic position and morphologic nature.

DICOTYLEDONAE

FAMILY MORACEAE

Genus FICUS LINNAEUS.

Ficus porcellanaria n. sp.

Plate 2, Figure 1

Leaf of unknown shape and dimensions, apparently somewhat inequilateral, with a broadly cuneate base and entire, somewhat wavy or sinuous margin; nervation pinnate, camptodrome; midrib bent or curved; secondary nerves irregularly spaced and disposed, leaving the midrib at approximately right angles or with a short, abrupt curve, thence extending almost straight for a greater or lesser distance, ultimately curving upward and connecting near the margin through a series of irregular loops that coalesce and form a continuous pseudo-marginal nerve; occasional minor intermediate secondary nerves extend from the midrib and soon become merged with the tertiary cross nervation from the major secondaries, forming an irregular meshwork of coarse and fine polygonal areolae.

[1] For purposes of comparison I have introduced, natural size (see text fig. 1), a photograph of the upper part of a floral bract of *Musa cavendishi* Lamb, taken from a specimen in the herbarium of The New York Botanical Garden, collected in Florida by Dr. J. K. Small, November, 1904. (Photo. by Dr. A. B. Stout, Nov. 19, 1923.)

This leaf does not appear to be comparable with any described fossil species, but it has the characteristic nervation, throughout, of that of several existing species of *Ficus*, such as *F. velutina* Willd., *F. mitrophora* Warb., etc., and I have but little hesitation in referring it to that genus.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Ficus pseudoeggersii n. sp.

Plate 5, Figure 5; Plate 14, Figure 11

Leaf obovate in shape, apparently slightly unsymmetrical, 8.75 centimeters in length by 5.75 centimeters in maximum width, rounded above to a broad, blunt apex and curved below to a cuneate base, petiolate; margin entire; midrib curved, thickened below and terminating in a conspicuously thick petiole 1.1 centimeter in length; nervation pinnate, camptodrome; secondary nerves 9 or 10 on each side, irregularly alternate, leaving the midrib at obtuse angles of divergence, the lower two or three, especially on the concave side of the midrib, curved downward, the upper ones becoming straighter and ultimately curving slightly upward, all bending abruptly in the vicinity of the margin, forming a series of angular connecting loops, with nervilles extending from the angles toward the margin.

These leaves simulate certain of the leaves of the existing species *Ficus eggersii* Warb. so closely as to be almost indistinguishable from them; and they are also suggestive of leaves of *F. eugeniaefolia* (Liebm.) Helms. Unfortunately the finer, tertiary nervation is not visible, otherwise more critical and satisfactory comparison might be possible.

Locality and collectors: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921, (Pl. 5, Fig. 5.) Cuba. Cayajana River, Santa Clara. Bro. León and Fr. Roca, Aug. 7, 1918, (Pl. 14, Fig. 11.)

Ficus comparabilis n. sp.

Plate 4, Figures 2*a*, 2*b*; Plate 3, Figures 1*a*, 1*b*, 2; (Plate 5, Figures 2–4?)

Leaves obovate to obovate-elliptical in shape, varying in size from 7 to 10.5 centimeters in length by 5 to 7.5 centimeters in maximum width; apex cuneate-apiculate or obtuse and emarginate; base bluntly cuneate; margins entire; nervation pinnate, camptodrome; secondary nerves irregularly disposed and spaced, subtending angles of various degrees, generally obtuse, with the

midrib, the lower ones mostly at more obtuse angles than the upper ones and occasionally bent abruptly upward close to the midrib, all extending almost straight for a greater or lesser distance, ultimately curving upward and connecting in a series of rounded and angular loops that coalesce and form a continuous pseudo-marginal nerve with tertiary nervilles extending toward the margin; occasional minor intermediate secondary nerves extend from the midrib and merge with the tertiary cross nervation at various angles, forming an irregular network of coarse and fine polygonal areolae.

This species is represented by a large number of specimens in the collection from Trinidad. They resemble very closely certain of the leaf forms of the existing species *Ficus velutina* Willd., and certain specimens are also so suggestive of the two species last described that it is difficult to differentiate them. It is quite possible, in view of the great variability in the size and shape of leaves in many species of the genus, that our three species may merely represent various leaf forms of a single specific type. The fragmentary specimens represented by figures 2–4, on plate 5, are included, with question, in the species.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921, (Pl. 3, Figs. 1*a*, *b*, 2; Pl. 4, Figs. 2*a*, *b*.) Bluff just north of Moruga. Van Ingen, March 19, 1921, (Pl. 5, Figs. 2–4.)

Ficus domingensis n. sp.

Plate 13, Figure 6

Leaf of unknown shape and dimensions, broadly cordate at base, with entire margin; midrib coarse in its basal part; nervation pinnate, camptodrome; lower secondaries irregularly disposed and spaced, subtending approximately right angles with the midrib, looped and jointed toward their extremities, with tertiary nerves extending outward from the loops and joining so as to form irregular marginal areolae.

This specimen is too fragmentary to serve as a basis for a complete diagnosis and description of the leaf that it represents; but the characters are sufficiently well preserved to identify it with the genus *Ficus*, and to provide a suggestive comparison with the existing *F combsii* Warb., *F. mitrophora* Warb., etc.

Locality and collector: Hispaniola. Cibao Valley, Santo Domingo. Gabb, 1868.

Ficus pseudonitida n. sp.

Plate 15, Figure 6

Leaf oval-elliptical in outline, tapering to base and apex, 5.25 centimeters in length by 2.3 centimeters in width approximately across the middle; margin entire; nervation pinnate; secondary nerves leaving the midrib at angles of approximately 40°, fine, subparallel, consisting of a relatively conspicuous series distant about 3 millimeters from each other, with finer ones between, all merging together toward their extremities and connected by cross nervation, forming irregular polygonal reticulations and terminating in an obscurely defined, wavy, marginal nerve.

This leaf is so closely comparable with those of the existing *Ficus nitida* Thunb. as to be almost indistinguishable. The apex in our specimen is missing, however, hence no comparison of this feature is feasible; but the outline and the characters of the nervation are, apparently, identical.

Locality and collector: Cuba. Finca "Flores de San Juan," near Jatibouico River, Santa Clara. Rafael Garteiz, Feb. 1918.

Ficus sp.

Plate 13, Figure 2

A fragment of the upper portion of a leaf, that was originally, apparently, linear-lanceolate in shape. The margin is entire; nervation pinnate, camptodrome; secondary nerves subtending obtuse angles with the midrib, irregularly spaced, extending almost straight, or somewhat flexed, to the marginal region, where they connect with each other in a series of angular loops with fine tertiary nervilles extending from the angles toward the margin.

This specimen is too fragmentary for either adequate description or satisfactory comparison. It apparently was similar, however, to the type of leaf represented by the existing species *Ficus lancifolia* Hook. & Arn. (= *F. donnell-smithii* Standley ?), and by *F. wilcoxensis* Berry [1] from the Eocene Tertiary of Tennessee.

Locality and collector: Hispaniola. Cibao valley, Santo Domingo. Gabb, 1868.

[1] Berry, E. W. The lower Eocene floras of southeastern North America. U. S. Geol. Survey, Prof. Paper 91, p. 202, pl. 27, fig. 6. 1916.

Genus Coussapoa Aublet

Coussapoa vaningeni n. sp.

Plate 6, Figure 1

Leaf ovate-lanceolate in outline, narrowly wedge-shaped at the apex, broadly wedge-shaped at the base, petiolate, 6 centimeters in length exclusive of the 1.2 centimeter petiole, 3.4 centimeters in maximum width; margin entire; nervation simply pinnate; secondary nerves 9 or 10 on each side, irregularly alternate or occasionally subopposite, uniform and subparallel throughout, leaving the midrib at angles of approximately 45°, and extending, almost straight, close to the margin, where they bend abruptly upward and join each other, forming an obscurely defined marginal nerve; tertiary nervation fine, crowded, uniform, approximately perpendicular to the secondaries throughout.

There can be but little doubt in regard to the generic affinities of this specimen, and it is suggestive of certain of the smaller leaves of the existing species, *Coussapoa latifolia* Aubl.

A subpalmate species of the genus, from the Tertiary of Venezuela, was described and figured by Berry,[1] under the name *Coussapoa villosioides* (*loc. cit.*, pp. 563–566, pl. 108, figs. 1–4, text fig. 2), in which the characteristic nervation of the genus is well shown in the restoration of the leaf represented in the text figure above cited.

The specific name given to our specimen is in honor of the collector, Prof. Gilbert van Ingen.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Family Polygonaceae

Genus Coccoloba Linnaeus

Coccoloba simulans n. sp.

Plate 15, Figures 3, 4

Leaves ovate in shape, varying in size from 4.5 to 7 centimeters in length by 2.75 to 5 centimeters in maximum width, tapering above to a cuneate apex and rounded below to a broad, curved or subcordate base; margins entire; nervation pinnate, camptodrome; midrib straight; secondary nerves irregularly spaced and disposed, subtending rather uniform angles of about 45° to 50° with the midrib, mostly straight, occasionally forked toward

[1] Berry, E. W. Tertiary fossil plants from Venezuela. U. S. Nat. Mus., Proc. vol. 59, pp. 553–579, pls. 107–109 and text figs. 1–4. 1921.

their extremities, curved upward and becoming irregularly camptodrome in the marginal region.

These two leaves do not appear to possess any character, other than that of size, by which they may be differentiated, and I have ventured, therefore, to include both under the same specific name. The larger specimen, represented by our Figure 3, may be compared with leaves of the existing *Coccoloba laurifolia* Jacq., and *C. pyrifolia* Desf., and the smaller one, represented by Figure 4, with *C. krugii* Lindau and *C. reflexa* Lindau. In each of these species there is a wide diversity in the shape and size of the leaves, and our two specimens do not differ from each other to the same extent as, in many instances, may be seen on a single bush or individual branch of either of the species above mentioned.

Locality and collectors: Cuba. Cayajana River, Santa Clara. Bro. León and Fr. Roca, Aug. 7, 1918.

Coccoloba(?) sp.

Plate 9, Figure 8

Leaf of unknown shape and dimensions, but apparently broadly ovate and approximately 11 centimeters in length by 10 centimeters in maximum width; midrib stout, flexuous; secondary nerves coarse, irregularly disposed and spaced, subtending angles of 40° to 45° with the midrib, flexed, curved slightly upward and bent abruptly upward toward their extremities; tertiary nervation not discernible.

I infer that this fragmentary specimen represents the distorted remains of a large leaf similar in shape to certain of those of existing species such as *Coccoloba cruegerii* Griseb., but, by reason of the base of the leaf being broken off, it is impossible to determine what were the original characters of the basal nervation.

The coarseness of the secondary nerves, and the manner in which they bend abruptly upward at their extremities, however, are points of mutual resemblance, and the absence of any trace of tertiary cross nervation in our specimen also leads to the inference that it was probably fine and uniform, such as obtains in many of the leaves of the genus to which I have tentatively referred it.

Locality and collectors: Porto Rico. Guajataca River, south bank, about one fourth mile north of Lares ("Collazo shales, uppermost of the series"). Reeds, Hubbard, and Hill, 1915.

Family Anonaceae

Genus Anona Linnaeus

Anona saraviana Berry?

Plate 9, Figure 3

Anona saraviana Berry. Miocene plants from southern Mexico. U. S. Nat. Mus., Proc. vol. 62, art. 19, p. 8, pl. 3, fig. 2. 1923.

I have referred this fragmentary specimen, tentatively, to the species described and figured by Berry (*loc. cit.*) from the Miocene of Mexico, although his generic identification does not appear to be altogether conclusive.

Locality and collector: Porto Rico. Guajataca River, south bank, about one fourth mile north of Lares ("Collazo shales, uppermost of the series"). Reeds, Hubbard, and Hill, 1915.

Family Lauraceae

Genus Nectandra Roxburgh

Nectandra pseudoantillana n. sp.

Plate 15, Figures 1, 2

Leaves relatively long and narrow, apparently elongated ellipsoidal in shape and approximately 11 to 12 centimeters in length by 3.25 centimeters in maximum width; base narrowly wedge-shaped; margin entire; nervation simply pinnate, camptodrome; secondary nerves irregularly spaced and disposed, subtending angles of about 40° with the midrib, ascending, slightly curved or flexed, thinning toward their extremities, and ultimately coalescing through a series of successively finer and finer loops and cross nervilles; tertiary nervation forming a network of relatively coarse and fine polygonal areolae throughout.

These specimens evidently represent lauraceous leaves, and they may be more or less satisfactorily compared with leaves of existing species in any one of several different genera, but especially in the genus *Nectandra* as now differentiated and recognized. Leaves that appear to be almost indistinguishable from our specimens, in all of their discernible characters, may be found on specimens of *N. antillana* Meissn., *N. coriacea* (Sw.) Griseb., *N. cuspidata* Nees, *N. membranacea* (Sw.) Griseb., *N. pallida* Nees, and *N. rectinervia* Meissn., each of which shows more or less variation in leaf form.

A fossil species from the Miocene Tertiary of Peru, that resembles ours somewhat closely, and is probably generically identical, was described and figured by Berry [1] under the name *Mespilodaphne tumbezensis*.

Incidentally it is of interest to note that certain of the leaves of *Nectandra antillana* with which our specimens were most satisfactorily compared were collected from plants growing in the same general locality as that where the fossil specimens were found.

Locality and collectors: Cuba. Cayajana River, Santa Clara. Bro. León and Fr. Roca, Aug. 7, 1918.

Genus Ocotea Aublet

Ocotea pseudomartinicensis n. sp.

Plate 7

Leaf elliptical in shape, 16 centimeters in length by 7 centimeters in maximum width, curved slightly outward and cuneate at the base, curved rather abruptly inward and cuneate-acuminate at the apex; margin entire, slightly undulate; nervation simply pinnate, camptodrome; secondary nerves irregularly disposed, leaving the midrib at angles of approximately 45°, curving upward, thinning toward their extremities and ultimately coalescing in a series of successively smaller and smaller loops close to the margin; occasional minor secondary nerves, irregularly disposed and spaced, connect and merge into the tertiary cross nervation and form a broken, irregular network of quadrangular and polygonal areolae throughout.

This specimen is so closely similar to the leaves of certain existing species of *Ocotea* as to be practically impossible of differentiation, as far as the obvious surficial characters are concerned. In particular it may be compared with *O. martinicensis* Mez, and *O. macrophylla* (Meisn.) Mez.

It is also strikingly suggestive of the two leaves described and figured by Berry,[2] from the Miocene Tertiary of Costa Rica and Mexico, respectively, that he referred to *Nectandra areolata* Engelhardt,[3] a Tertiary species from the Miocene of Colombia.

[1] Berry, E. W. Miocene fossil plants from northern Peru. U. S. Nat. Mus., Proc. vol. 55, p. 291, pl. 15, fig. 3. 1919.

[2] Berry, E. W. Tertiary fossil plants from Costa Rica. U. S. Nat. Mus., Proc. vol. 59, p. 177, pl. 27. 1921. Miocene plants from southern Mexico. *Idem*, vol. 62, p. 19, pl. 4, fig. 3. 1923.

[3] Engelhardt, Hermann. Über neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 29, pl. 6, figs. 1, 2. 1895.

The fossil species that appears to simulate ours most closely, however, is *Persea macrophylloides* Engelhardt,[1] from the Miocene Tertiary of Chile and Colombia. Comparison with the figure last cited, in fact, may be seen to show such identity of characters that the two figures might be interchangeable in illustrating either species, except for a slight difference in size. I am inclined to believe that the two may eventually be determined to be specifically identical.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Genus ANIBA Aublet

Aniba portoricensis n. sp.

Plate 9, Figures 4, 5

Leaves apparently narrowly obovate or oblanceolate in shape, about 9 to 10 centimeters in length by 3 centimenters in maximum width, narrowed below to a long, attenuated base; margins entire, irregularly curved or sinuous; nervation pinnate, camptodrome; secondary nerves irregularly spaced, mostly opposite, especially the lower ones, subtending various angles with the midrib, mostly flexed, curved toward their extremities, the curves following the contour of the adjacent margin and ultimately becoming comptodrome.

These fragmentary remains might be more or less satisfactorily compared with any one of a dozen or more existing lauraceous species in the genera *Mespilodaphne*, *Oreodaphne*, *Ocotea*, *Ampelodaphne*, *Aniba*, etc. The reference to the genus *Aniba* is, therefore, to be regarded as representing their family rather than their definite generic relationship.

Locality and collectors: Porto Rico. Guajataca River, south bank, about one fourth mile north of town of Lares ("Collazo shales, uppermost of the series"). Reeds, Hubbard, and Hill, 1915.

Genus LAUROPHYLLUM Goeppert

Laurophyllum dubiosum n. sp.

Plate 12, Figures 1–3

Leaves ovate-ellipsoidal in shape, varying in size from 6 to 8 centimeters in length by 2.75 to 3.25 centimeters in maximum

[1] Engelhardt, Hermann. Über Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, no. 4, p. 650, pl. 5, fig. 3. 1891. Über neue Tertiärpflanzen Süd-Amerikas. *Idem*, vol. 19, p. 27, pl. 5, fig. 3. 1895.

width, tapering below to a more or less curved, cuneate base, and above to an apiculate apex; nervation pinnate; secondary nerves irregularly spaced and disposed, the lower ones leaving the midrib at acute angles of divergence, the upper ones at more obtuse angles, all curving upward toward their extremities.

I have referred these leaves to the comprehensive fossil genus *Laurophyllum* with the idea of indicating their probable relationship to the Lauraceae. They are too indefinite in their characters, however, to attempt identification with any living genus, although they may be compared, in a general way, with many leaf forms of species included in the genera *Acrodiclidium*, *Mespilodaphne*, etc.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Family Leguminosae

Genus Inga Linnaeus

Inga pseudonobilis n. sp.

Plate 5, Figure 6; Plate 10, Figure 7

Leaf or leaflet of unknown shape and dimensions, but apparently oblong-elliptical and approximately 12 centimeters in length by 4 centimeters in maximum width at about the middle, tapering to an acute, wedge-shaped, slightly inequilateral base; margin entire; nervation pinnate, camptodrome; secondary nerves subtending acute angles with the midrib, ascending, curving upward and extending close to the margin, ultimately coalescing and connecting through the almost straight tertiary cross nervation.

These fragmentary specimens, as far as their characters are preserved, may be compared with the existing South American species, *Inga bourgoni* DC. and *I. nobilis* Willd.

Locality and collector: Trinidad. Bluff just north of Moruga. Van Ingen, March 19, 1921, (Pl. 5, Fig. 6.) Porto Rico. Collazo River, at base of second falls below Carretera bridge. Hubbard, 1915, (Pl. 10, Fig. 7.)

Inga (?) sp.

Plate 12, Figure 5

This fragment, representing the upper part of a leaf with an acute apex and entire margin, would hardly be worthy of con-

sideration, except for its striking similarity to the apical portion of a leaf from the Tertiary of Santo Domingo, described and figured by Berry [1] under the name *Inga sanchezensis* (see Plate 12, Figure 6, introduced for comparison). I have, therefore, referred our specimen, tentatively, to the same genus.

Locality and collector: Porto Rico. Collazo River near base of second falls below Carretera bridge. Hubbard, June 9, 1915 (no. 83 a).

Genus PITHECOLOBIUM Martius

Pithecolobium pseudotrapezifolium n. sp.

Plate 10, Figure 8

Leaflet irregularly rounded-trapezoidal in shape, inequilateral, 4.75 centimeters in length, including the 3 millimeter petiole, by 2.75 centimeters in maximum width; apex wedge-shaped, blunt; base inequilaterally cuneate, tapering on one side, rounded on the other; margin entire; midrib curved; nervation pinnate-reticulate; secondary nerves fine, numerous, leaving the midrib at angles of about 45°, more or less flexed, curving upward and forming with the tertiary cross nervation a series of somewhat elongated, reticulated areolae.

This well-defined leaflet is difficult to differentiate, as far as its surficial characters are concerned, from those of the existing species, *Pithecolobium glomeratum* Benth. and *P. trapezifolium* Benth., as depicted by Ettingshausen [2] in his "Blatt-Skelete," under the genus *Inga*. It is also very similar to *Pithecolobium tenuifolium* Engelhardt,[3] a Tertiary species from Colombia, which he compared (*loc. cit.*) with *P. glomeratum* Benth. Apparently the only discernible difference between Engelhardt's species and ours is that the latter is of larger dimensions. It is evident that the two must be regarded as closely allied if not specifically identical.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

[1] Berry, E. W. Tertiary fossil plants from the Dominican Republic. U. S. Nat. Mus., Proc. vol. 59, p. 120, pl. 21, fig. 11. 1921.

[2] Ettingshausen, Constantin von. Die Blatt-skelete der Dikotyledonen, p. 225, pl. 90, fig. 10; pl. 91, fig. 2, and p. 226, figs. 266, 267, and pl. 95, fig. 7. 1861.

[3] Engelhardt, Hermann. Über neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 31, pl. 3, fig. 21. 1895.

Pithecolobium vexativum n. sp.

Plate 11, Figure 4

Leaflet inequilateral, curved on one side, longitudinally truncate at the base and rounded above on the opposite side, about 6 centimeters in length by 2.4 centimeters in maximum width, asymmetrically cuneate at the base; midrib curved; nervation pinnate, camptodrome; secondary nerves fine, leaving the midrib at acute angles of divergence on the convex side, and at obtuse angles on the concave side, all curving upward and becoming camptodrome in the marginal region; minor intermediate secondaries obscurely defined.

This specimen appears to represent one of the terminal leaflets of a leguminous plant similar to the existing species *Pithecolobium ligustrinum* (Jacq.) Klotz.; although a more perfect specimen might show apical characters that would indicate some other generic relationship.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, 1915.

Genus Cassia Linnaeus

Cassia sipariensis n. sp.

Plate 1, Figure 1

Leaflet lanceolate in shape, 3.5 centimeters in length by 1.2 centimeters in maximum width, tapering above to a narrow, acuminate apex and below to a rounded cuneate base; margin entire; nervation pinnate, reticulate-camptodrome; midrib straight; secondary nerves numerous, fine, leaving the midrib at angles of about 45°, curved and flexed toward their extremities and merged with the tertiary cross nervation, forming a reticulated network of irregular sized, polygonal areolae.

This leaflet may be compared with those of several existing species of *Cassia*, such as *C. leptocarpa* Benth., *C. occidentalis* L., and *C. spectabilis* DC., and it is also similar to certain leaves that have been described and figured under the fossil genus *Podogonium*, such as *P. americanum* Lesquereux,[1] from lower Tertiary horizons in our western States, and other species from the Miocene Tertiary of the Old World, of which *P. knorrii* Heer [2] is a very good example.

[1] Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (Tertiary flora), p. 298, pl. 59, fig. 5; pl. 63, fig. 2; pl. 65, fig. 6. 1878.

[2] Heer, Oswald. Flora tertiaria Helvetiae, vol. 3, p. 114, pl. 134, fig. 24; pl. 136, fig. 4. 1859.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Cassia(?) **dubiosa** n. sp.

Plate 10, Figure 4

Leaflet ellipsoidal in shape, slightly inequilateral, tapering on one side and rounded on the other to a cuneate base; margin entire; midrib straight; nervation pinnate; secondary nerves fine, leaving the midrib at angles of about 40°, ascending and curving upward toward their extremities.

The systematic position of this specimen has not been satisfactorily determined. The apex is missing and the nervation is obscurely defined and incomplete. It is assumed to belong in the Leguminosae largely because of its asymmetry, which is quite obvious, especially in connection with the base. It might, perhaps, be more consistent, under the circumstances, to refer the specimen to the comprehensive fossil genus *Leguminosites*, but it appears to be sufficiently like leaflets of certain existing species of *Cassia* to justify at least provisional reference to the genus. Other fossil leaves of similar appearance have also been referred to the genus, such as *C. glenni* Berry,[1] from the Eocene Tertiary of Tennessee—especially the specimen represented by his figure 18 (*loc. cit.*).

Locality and collector: Porto Rico. Collazo River, near the base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Genus Sophora Linnaeus

Sophora(?) **suspecta** n. sp.

Plate 10, Figure 3

Leaflet inequilateral, about 3 centimeters in length by 1.3 centimeter in maximum width, tapering above to a curved, blunt apex; margin entire; midrib curved; nervation pinnate; secondary nerves fine, leaving the midrib at angles of approximately 50°, at first almost straight, then curving upward.

Although the base of this specimen is lacking, and the nervation is obscurely defined, there can be but little doubt that it represents the leaflet of some species belonging to the Leguminosae; and as it compares more or less closely with those of the existing

[1] Berry, E. W. The lower Eocene floras of southeastern North America. U. S. Geol. Survey, Prof. Paper 91, p. 233, pl. 45, figs. 15, 16, 17*a*, 18. 1916.

species *Sophora affinis* T. & G. I have ventured to include it, tentatively, in that genus.

A fossil species that appears to resemble it very closely is *Sophora paleolobifolia* Berry,[1] from the Eocene Tertiary of Tennessee; and comparisons might also be made with certain fossil species referred to the existing genus *Pithecolobium*, and to the comprehensive fossil genus *Leguminosites;* but any such comparisons would be of little value in view of the incompleteness of our specimen.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Genus DALBERGIA Linnaeus

Dalbergia gabbi n. sp.

Plate 13, Figure 5

Leaf ovoid-ellipsoidal in shape, slightly inequilateral, 4.75 centimeters in length, including the 4 millimeter petiole, by 2.8 centimeters in maximum width; margin entire; midrib straight; nervation pinnate, reticulate; secondary nerves fine, numerous, consisting of a major series with nerves of minor rank disposed between, all leaving the midrib at obtuse angles of divergence, irregularly flexed or angled toward their extremities and connected by tertiary cross nervation, forming a reticulated network of polygonal areolae.

This leaf is almost certainly referable to the Leguminosae and may be compared with certain of the broad, rounded leaf forms of the existing species, *Dalbergia variabilis* Vogel.

Locality and collector: Hispaniola. Cibao valley, Santo Domingo. Gabb, 1868.

FAMILY MELIACEAE

Genus SWIETENIA Jacquin

SWIETENIA sp.

Plate 13, Figure 1

Leaf of unknown shape and dimensions, inequilateral, curved, cuneate at the base, petiolate; petiole 7 millimeters in length; margin entire; midrib curved; nervation pinnate; secondary nerves prominent, irregularly disposed and spaced, ascending,

[1] Berry, E. W. The lower Eocene floras of southeastern North America. U. S. Geol. Survey, Prof. Paper 91, p. 243, pl. 52, fig. 1. 1916.

those on the convex side of the midrib subtending angles more acute than those on the concave side.

This fragmentary specimen is referred to the genus *Swietenia* on account of its general characters as revealed and indicated. It may be compared with leaflets of the existing *S. mahogoni* L.; but it is unfortunate that the fragmentary nature of the specimen is such that either adequate description or satisfactory comparison is alike impossible.

Locality and collector: Hispaniola. Cibao valley, Santo Domingo. Gabb, 1868.

Family Ilicaceae

Genus Ilex Linnaeus

Ilex pseudocassine n. sp.

Plate 14, Figures 6, 7

Leaves apparently obovate in shape, about 2.75 centimeters in length by 1.75 centimeter in maximum width, abruptly narrowed to an elongated base; margins entire; nervation pinnate; midrib straight; secondary nerves leaving the midrib at angles of about 45°, irregularly disposed and spaced, occasionally subopposite, especially the lower ones, the latter closer together than those above.

These specimens are suggestive of certain of the short, broad leaf forms of the existing *Ilex cassine* L., but their condition is too fragmentary for any more definite comparison.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Ilex pseudomyrtifolia n. sp.

Plate 14, Figure 8

Leaf apparently oblanceolate or spatulate in shape, inequilateral, 2.75 centimeters in length by .9 centimeter in maximum width, tapering to a narrow, elongated base; margin entire; nervation pinnate.

I have referred this small leaf, with some hesitation, to the genus *Ilex*. The apex is missing and the nervation is imperfectly preserved and obscurely defined; but it may be compared with numerous leaf forms of the existing *I. myrtifolia* Walt.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Family Sapindaceae

Genus Sapindus Linnaeus

Sapindus obesus n. sp.

Plate 10, Figures 1, 2

Leaves or leaflets inequilateral, about 7.5 centimeters in length by 3.25 centimeters in maximum width, broadly subfalcate in shape, bulging on the convex side, more or less flattened on the concave side, tapering above to an attenuated apex and below to an inequilateral, curved, wedge-shaped base; margin entire; nervation simply pinnate; midrib curved and slightly flexed toward the apex; secondary nerves irregularly spaced and disposed, ascending, curving upward toward the margin and subtending various, mostly acute angles with the midrib.

These two specimens compare satisfactorily with leaflets that are characteristic of several Sapindaceous genera, and they simulate very closely those of certain existing species of *Sapindus;* but whether or not both of our specimens should be referred to one and the same species may, perhaps, be regarded as an open question.

They may also be compared with *Sapindus acuminatus* Engelhardt,[1] from the Tertiary of Chile, from which they appear to differ mostly in their greater width. Interesting comparisons may also be made with *S. caudatus* Lesquereux [2] and *S. obtusifolius* Lesquereux,[3] from Eocene Tertiary horizons in the western United States. Our specimens appear to be intermediate in shape between the three species mentioned; but they all differ between themselves but little more than do the leaflets on many individual trees of certain existing species.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915 (no. 83*a*).

Family Rhamnaceae

Genus Zizyphus Linnaeus

Zizyphus sp.

Plate 14, Figure 5

A fragmentary piece of the upper part of a leaf of unknown shape and dimensions, apparently ellipsoidal, with an acuminate

[1] Engelhardt, Hermann. Über Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, no. 4, p. 670, pl. 9, fig. 10. 1891.

[2] Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (Tertiary flora), p. 264, pl. 48, fig. 6. 1878.

[3] *Idem*, p. 266, pl. 49, figs. 8–11.

apex; margin entire; nervation consisting of a straight midrib, two acrodrome, lateral primaries, and numerous fine, curved and flexed, secondary nerves, one series connecting the midrib and lateral primaries, another series branching from the outer sides of the lateral primaries, curving upward, ultimately connecting and forming a wavy, pseudo-marginal nerve.

Although only a piece of the leaf represented by this specimen is preserved, it includes enough of the nervation to identify it, with reasonable certainty, as a species of *Zizyphus;* but the absence of the basal and apical parts makes any satisfactory comparison or any complete description impossible.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Family Guttiferae (Clusiaceae)

Genus Clusia Linnaeus

Clusia vera n. sp.

Plate 6, Figures 2, 3

Leaves broadly spatulate in outline, about 10 centimenters in length by 8 centimenters in maximum width; margin entire; midrib conspicuously thin distally, expanded proximally; nervation simply pinnate; secondary nerves fine, parallel, apparently uniform in rank, about 1.75 to 2 millimeters distant from each other, leaving the midrib at obtuse angles of divergence, the proximal ones almost straight, the distal ones slightly curved upward, all terminating in an obscurely crenulated marginal or paryphodrome nerve.

These specimens are so closely similar to leaves of certain existing species of *Clusia* (*C. alba* Jacq., *C. grandiflora* Splitz., *C. palmacida* Rich., etc.) that it is practically impossible to differentiate between them. The secondary nervation is somewhat obscurely defined and it is difficult to determine, with certainty, if all of the nerves are equal in rank, but apparently they are.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

FAMILY FLACOURTIACEAE

Genus SAMYDA Linnaeus

Samyda matanzensis n. sp.

Plate 14, Figure 1

Leaf linear-oblong in shape, about 6 centmeters in length by 1.5 centimenters in width, terminating below in a rounded cuneate base, petiolate; petiole 6 millimeters in length; margin entire at the base, becoming obscurely and ultimately finely dentate above; nervation pinnate, craspedodrome, the ultimate branches of the secondary nerves terminating in the marginal dentitions.

This leaf is closely similar to those of the existing species *Samyda grandiflora* Griseb., with certain specimens of which it might well be regarded as specifically identical.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

FAMILY MYRTACEAE

Genus MYRCIA DeCandolle

Myrcia pseudorostrata n. sp.

Plate 8, Figure 6*a*

Leaf apparently linear-lanceolate in shape, about 8 centimeters in length, exclusive of the 1 centimeter petiole, by 2.2 centimeters in maximum width; margin entire; nervation simply pinnate; secondary nerves all of equal rank, fine, almost straight, parallel with each other, equally spaced at a distance of about 1 millimeter apart, subtending angles of about 85° with the midrib; tertiary nervation obscure, forming fine reticulations in connection with the secondaries.

The imperfect condition of this specimen makes accurate comparison with either existing or fossil species impossible. It is apparently, however, a species of *Myrcia*, of the same general type as any one of several existing narrow leaved species, such as *M. rostrata* DC., and is closely similar to *M. reticulato-venosa* Engelhardt,[1] from the Tertiary of Chile, which he compared with the existing *M. corcovadensis* Berg.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

[1] Engelhardt, Hermann. Über Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, no. 4, p. 680, pl. 8, fig. 1. 1891.

Myrcia eugenioides n. sp.

Plate 9, Figures 6, 7

Leaves ovate-lanceolate in shape, petiolate, coriaceous in texture, varying in size from 3 to 4 centimeters in length by 1.25 to 1.75 centimeter in maximum width, tapering above to a long, acuminate apex and below to a curved, wedge-shaped base; margins entire; midrib straight above, slightly bent or curved in the lower part and terminating in a petiole about 2.5 millimeters in length; nervation, exclusive of the midrib, not discernible.

It is always unsatisfactory to attempt to identify fossil leaf specimens from the shape alone; but in this instance there appears to be but little doubt that we are dealing with leaves that are referable to the Myrtaceae, and they may be compared with those of the existing species *Myrcia sylvatica* DC., and *Eugenia procera* Poir., in each of which there is considerable variation in the shape and size of the leaves. Our Figure 6 is also suggestive of a leaf from the Tertiary of the Republic of Santo Domingo, described and figured by Berry [1] under the name *Sapindus hispaniolana*, which appears to differ from our Figure 6 merely in its more attenuated apex.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera Bridge. Hubbard, June 9, 1915.

Genus Eugenia Linnaeus

Eugenia comparabilis n. sp.

Plate 8, Figures 2–5, 6*b*

Leaves oblong-ellipsoidal in shape, occasionally distally curved or turned to one side, 5 to 6 centimeters in length by 2.25 to 2.50 centimeters in maximum width, tapering or rather abruptly contracted to a blunt, apiculate apex, rounded below to a curved, cuneate base; margins entire, and flexed or contorted in connection with the distally curved leaves; midrib straight, or flexed, and curved at the apex in connection with the distally curved leaves; nervation pinnate, camptodrome; secondary nerves fine, irregularly disposed and spaced, consisting of a well-defined major series and numerous intermediate minor nerves, all leaving the midrib at obtuse angles of divergence, subparallel, straight for a greater or less distance proximally, flexed and curved abruptly upward distally, ultimately connected in a series of

[1] Berry, E. W. Tertiary plants from the Dominican Republic. U. S. Nat. Mus., Proc. vol. 59, p. 122, pl. 21, fig. 3. 1921.

angular loops that form a continuous pseudomarginal nerve, with nervilles extending from the angles toward the margin; tertiary cross nervation merged with the intermediate secondaries forming an irregular, reticulated network of polygonal areolae.

I have inferred that our Figures 5 and 6*b* represent contorted specimens, and that Figures 2–4 represent normal specimens of the species. They may be compared with any one of a dozen existing species in the genera *Myrcia* and *Eugenia*, such as *M. phaeoclada* Berg., *M. selloana* Berg., *E. coffeifolia* DC., and *E. forameoides* Rich.

They are also more or less suggestive of the fossil species *Myrcia* (*Cryptomyrcia*) *nitens* Engelhardt,[1] from the Tertiary of Chile.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Genus Psidium Linnaeus

Psidium ? sp.

Plate 12, Figure 4

A fragmentary lower part of a leaf of unknown shape and dimensions that, apparently, was coriaceous in texture, and oblong or oblong-elliptical in shape, with a rounded, cuneate base; margin entire; nervation pinnate; secondary nerves prominent, spaced irregularly at distances of about 5 to 6 millimeters from each other, opposite, subopposite or alternate in disposal, leaving the midrib at obtuse angles of divergence, curving upward distally.

This leaf is manifestly too fragmentary for satisfactory generic identification. I have, however, referred it tentatively to the genus *Psidium*, on account of its general resemblance to basal portions of leaves of the existing species *P. guajava* L. and *P. pomiferum* L.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

[1] Engelhardt, Hermann. Über Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, no. 4, p. 679, pl. 10, fig. 7. 1891.

Family Myrsinaceae

Genus Geissanthus Hooker

Geissanthus brittoni n. sp.

Plate 2, Figures 2, 3

Leaves obovate-spatulate in shape, more or less inequilateral, varying in size from 6.5 centimeters in length by 3 centimeters in maximum width to 8.5 centimeters in length by 4 centimeters in maximum width, tapering below to a long, narrow base and abruptly contracted above to a short, apiculate apex; margin entire; nervation pinnate, camptodrome; secondary nerves irregularly disposed, subtending angles of approximately 60° with the midrib on the broader side of the leaf and about 40° on the narrower side, all curving upward toward their extremities, merging with the tertiary nervation in the marginal region, and forming a series of loops and polygonal areolae that diminish in size successively upward; minor secondary nerves, extending from the midrib, merge with the tertiary cross nervation and form a reticulated network of polygonal areolae throughout.

These specimens may be compared with the existing species *Geissanthus bangii* Rusby, *G. boliviana* Britton, and *Peckia* (*Cybianthus*) *psychotriaefolia* Rusby. As far as I am aware no fossil species has been heretofore referred to either of these genera, although several species have been recognized in other genera of the Myrsinaceae.

I take great pleasure in naming the species for Dr. N. L. Britton to whose initiative ~~we are~~ indebted for having brought the material to light.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Genus Icacorea Aublet

Icacorea prisca n. sp.

Plate 11, Figure 5

Leaf ovate-ellipsoidal in shape, about 11 centimeters in length by 4 centimeters in maximum width, narrowed to a slightly asymmetrical, elongated base; margin entire; nervation pinnate; secondary nerves relatively fine, numerous, the lower ones leaving the midrib at acute angles of divergence, the upper ones at angles of about 80°.

It is with some hesitation that this imperfect specimen is referred to the genus *Icacorea;* but it may be compared, more or

less satisfactorily, with the existing species *I.* (*Ardisia*) *latipes* Mart. The characters of the nervation, however, are too obscurely defined for critical comparison.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Genus Stylogyne A. DeCandolle

Stylogyne? fragmenta n. sp.

Plate 10, Figure 6

Fragmentary remains of what was apparently a leaf about 11 centimeters in length by about 5 centimeters in maximum width, broadest above the middle, slightly inequilateral, with a curved, cuneate base, concave on one side, convex on the other; margin entire; nervation pinnate, camptodrome-reticulate; secondary nerves flexed or wavy angled, irregularly spaced, subtending angles of approximately 60° with the midrib, curving upward toward their extremities and ascending in the marginal region, where they apparently coalesce; obscurely defined minor secondaries occur between the major ones and merge with the tertiary cross nervation, forming a reticulated network of irregular, polygonal areolae throughout.

The correct systematic position of this fragment must be regarded as uncertain. It apparently belongs in the Myrsinaceae, and I have referred it, provisionally, to the genus *Stylogyne* on account of its general resemblance to leaves of the existing *S. lateriflora* (Sw.) Mez., as far as similar portions can be compared.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Family Sapotaceae

Genus Bumelia Swartz

Bumelia reclinatafolia Berry

Plate 14, Figure 9

Bumelia reclinatafolia Berry. Tertiary fossil plants from the Dominican Republic. U. S. Nat. Mus., Proc. vol. 59, p. 125, pl. 21, fig. 4. 1921.

There can be but little doubt that our specimen is identical with the leaf from the Tertiary of the Republic of Santo Domingo, described and figured under the above name by Berry (*loc. cit.*),

which he compared with the existing *Bumelia reclinata* Vent. and *B. angustifolia* Nutt.; although it might be compared almost equally well with leaves of existing species in the genus *Maytenus*, as represented by *M. elaeodendroides* Griseb. and *M. phyllanthoides* Benth. In the absence of any traces of secondary nervation, however, the differentiation between leaves of the several species in the genera mentioned is practically impossible.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Genus Mimusops Linnaeus

Mimusops leonii n. sp.

Plate 14, Figure 10

Leaf oblong-ovate in shape, 6.5 centimeters in length by 3.25 centimeters in maximum width, curved-cuneate at the base, rounded and slightly retuse at the apex; margin entire; nervation pinnate; secondary nerves leaving the midrib at obtuse angles, the lower ones at right angles, numerous, fine, irregularly disposed, subparallel, almost straight.

This specimen may be compared with certain leaves of the existing species *Mimusops surinamensis* Miq. I take pleasure in naming it for Bro. León, to whom we are indebted for much of our information in regard to the fossil flora of Cuba.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Mimusops jumuriensis n. sp.

Plate 14, Figures 3, 4

Leaves roughly oblong in shape, about 4 centimeters in length by 2 centimeters in maximum width, rounded-truncate at the base; margins entire; nervation pinnate; secondary nerves leaving the midrib almost at right angles, numerous, fine, irregularly disposed, subparallel, almost straight.

Although more or less fragmentary, these specimens appear to be referable to leaves of certain species of the genus *Mimusops*, and they may be compared with those of the existing *M. parvifolia* (Nutt.) Radlk. They are also highly suggestive of *M. praeparvifolia* Berry,[1] from the Tertiary of the Republic of Haiti, which species he compared, also, with *M. parvifolia.* I am

[1] Berry, E. W. Tertiary fossil plants from the Republic of Haiti. U. S. Nat. Mus., Proc. vol. 62, art. 14, p. 8, pl. 1, fig. 10. 1922.

inclined to believe that the Haitian and Cuban specimens may be specifically identical with each other; but our specimens are too fragmentary for definite identification.

Locality and collectors: Cuba. Abra del Jumurí, Matanzas. Bro. León and Fr. Roca, July 1918.

Family Apocynaceae

Genus Plumiera Linnaeus

Plumiera alia n. sp.

Plate 5, Figure 1

Leaf of unknown shape and dimensions, but apparently narrowly oblong in outline and about 3.5 centimeters in maximum width, with a rounded base; margin entire; nervation simply pinnate; secondary nerves uniform, straight, parallel, evenly spaced at about 5 millimeters distance from each other, subtending angles of approximately 90° with the midrib.

Although this specimen is fragmentary, the peculiar and characteristic secondary nervation leaves but little doubt that it represents the genus to which it is here referred. Existing species with which it may be most closely compared are *Plumiera sericifolia* Wright, and *P. emarginata* Griseb., both of them native in the West Indies.

Locality and collector: Trinidad. Bluff just north of Moruga. Van Ingen, March 19, 1921.

Plumiera evidens n. sp.

Plate 10, Figure 5

Leaf of unknown shape and dimensions, but apparently narrowly lanceolate in outline and about 3 centimeters in maximum width; margin entire; nervation simply pinnate; secondary nerves alternate, rather uniformly spaced at distances of approximately 7.5 millimeters from each other, subtending obtuse angles of about 80° with the midrib, extending straight, and parallel with each other, to about 3 to 4 millimeters from the margin, thence bending abruptly upward and connecting in a series of flattened angular loops that coalesce and form an irregular, submarginal nerve.

This fragmentary specimen may be compared with the leaves of any one of several existing species of *Plumiera*, more especially with *P. rubra* L., *P. bracteata* A. DC., and *P. succuba* Spruce. In its entirety it was, apparently, relatively long and narrow in

shape, and similar in general appearance to *Apocynophyllum mexicanum* Berry,[1] from an horizon in southern Mexico, tentatively assumed to be of Miocene Tertiary age. It differs from *P. trinitensis*, the species last described, in its more upright and more widely spaced secondaries.

Locality and collector: Porto Rico. Collazo River, near base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Genus HANCORNIA Gomez

Hancornia pseudopubescens n. sp.

Plate 11, Figure 7

Leaf of unknown shape and dimensions, apparently oblong or oblong-elliptical, and approximately 8 centimeters in length by 4 centimeters in maximum width; margin entire; nervation pinnate; secondary nerves fine, numerous, consisting of a major and a minor series, between which it is often difficult to differentiate, all leaving the midrib at almost right angles, more or less flexed or angled, slightly curved upward or almost straight, connected by tertiary cross nervation at the angles, forming elongated and short polygonal areolae that give the appearance of a reticulated network, especially in the marginal region.

This fragmentary specimen compares very satisfactorily, in shape and in the character of the nervation, with the median parts of leaves of the existing species *Hancornia speciosa* Gomez and *H. pubescens* Nees & Mart.

Locality and collector: Porto Rico. Collazo River, at base of second falls below Carretera bridge ("Collazo shales, lowermost of the series"). Hubbard, 1915.

Hancornia minor n. sp.

Plate 11, Figure 6

Leaf of unknown shape and dimensions, apparently linear oblong-elliptical, and approximately 6 centimeters in length by 2 centimeters in maximum width; margin entire; nervation pinnate; secondary nerves numerous, fine, apparently of major and minor rank, leaving the midrib almost at right angles of divergence, slightly flexed or angled or almost straight, parallel with each other, connected at the angles by tertiary cross nervation.

This fragment may, possibly, be merely a narrow leaf form of *Hancornia pseudopubescens*, the species last described, and it may

[1] Berry, E. W. Miocene plants from Southern Mexico. U. S. Nat. Mus., Proc. vol. 62, art. 19, pl. 23, pl. 4, fig. 2. 1923.

be compared with narrow leaf forms of the existing species *H. pubescens* Nees & Mart., and *H. speciosa* Gomez.

Locality and collector: Porto Rico. Collazo River, at base of second falls below Carretera bridge ("Collazo shales, lowermost of the series"). Hubbard, 1915.

Genus Aspidosperma Martius & Zuccarini

Aspidosperma collazoense n. sp.

Plate 11, Figures 1, 2

Leaves narrowly oblong-elliptical-falcate in shape, about 8 centimeters in length by 2.8 centimeters in maximum width, narrowed below to a blunt base; margin entire; midrib curved; nervation pinnate; secondary nerves numerous, of unequal rank, irregularly disposed and spaced, leaving the midrib at obtuse angles in the lower part of the leaf and at somewhat more acute angles above, proceeding almost straight and subparallel to within a short distance of the margin, where they apparently become camptodrome and merge more or less into the tertiary cross nervation.

These specimens may be more or less satisfactorily compared with leaves of the existing species *Aspidosperma polyneuron* Muell.

Locality and collector: Porto Rico. Collazo River, at base of second falls below Carretera bridge. Hubbard, June 9, 1915.

Genus Cameraria Linnaeus

Cameraria (?) incerta n. sp.

Plate 8, Figure 1

Leaf elliptical-obovate in shape, 3.8 centimeters in length by 2.75 centimeters in maximum width; margin entire; nervation pinnate; midrib straight; secondary nerves numerous, fine, straight, parallel, subtending angles of about 80° with the midrib.

I have referred this specimen, tentatively, to the genus *Cameraria* on account of its general resemblance to the existing species, *C. latifolia* Jacq. Unfortunately the extremities of base and apex in our specimen are lacking, but the indications are that each was acute. The nervation is too obscurely defined for accurate or satisfactory comparison, but it is strongly suggestive of the Apocynaceae. It might also be compared with leaves of *Aspidospermum discolor* A. DC. and *A. dispermum* Muell.

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

Genus Apocynophyllum Unger

Apocynophyllum pseudowillughbya n. sp.

Plate 11, Figure 3

Leaf ellipsoidal in shape, about 6 centimeters in length by 3.25 centimeters in maximum width, curved to the base, abruptly narrowed to the apex; margin entire; nervation pinnate; secondary nerves fine, numerous, subtending almost right angles with the midrib.

This leaf, although fragmentary, has the general shape and the characters of nervation that suggest relationship with the Apocynaceae; and it may be compared with the existing species *Willughbya scandens* Willd., as far as its visible and indicated original characters are concerned.

Locality and collector: Porto Rico. Collazo River, at base of second falls below Carretera bridge. ("Collazo shales, lowermost of the series"). Hubbard, 1915.

Apocynophyllum sp.

Plate 13, Figure 3

A fragmentary specimen of what was, apparently, a relatively long and narrow leaf, with numerous fine, parallel secondary nerves subtending angles of about 50° to 60° with the midrib, and obscurely defined tertiary nervation.

I have assumed, from the general characters of the nervation, that this fragmentary specimen belongs in the Apocynaceae, and have referred it to the comprehensive fossil genus *Apocynophyllum*. It may be compared with *A. tabellarum* (Lesquereux) Berry,[1] from the Eocene Tertiary of Tennessee, and with certain narrow-leaved species of the existing genus *Aspidosperma*.

Locality and collector: Hispaniola. Cibao valley, Santo Domingo. Gabb, 1868.

[1] Berry, E. W. The lower Eocene floras of southeastern North America. U. S. Geol. Survey, Prof. Paper 91, p. 343, pl. 103, fig. 5. 1916. (= *Salix tabellaris* Lesquereux.)

Family Bignoniaceae

Genus Bignonia Linnaeus

Bignonia sensibilis n. sp.

Plate 15, Figure 5

Leaf of unknown shape and dimensions, narrowed below to a broadly rounded, truncate-cuneate base; margin entire; nervation pinnate subpalmate; two lowest secondaries opposite, subbasilar, ascending, branched from the under or outer side; upper secondaries irregularly spaced, alternate, subtending obtuse angles with the midrib, curving upward; tertiary nervation more or less irregularly disposed, bent, flexed, or almost straight, subtending obtuse angles with the midrib and secondaries.

This is almost too imperfect a specimen for satisfactory comparison, but it resembles so closely certain existing species of *Bignonia* and allied genera that I feel justified in referring it to that genus, regarded in its broadest sense. It may be compared with *Arrabidaea obovata* DC., an existing Bolivian species of the Bignoniaceae, and with the fossil species *Bignonia grandifolia* Engelhardt,[1] from the Tertiary of Chile.

Locality and collectors: Cuba. Cayajana River, Santa Clara. Bro. León and Fr. Roca, Aug. 7, 1918.

Genus Crescentia Linnaeus

Crescentia [?] cucurbitinoides Berry

Plate 8, Figure 7; Plate 4, Figure 1

Crescentia cucurbitinoides Berry. Miocene plants from southern Mexico. U. S. Nat. Mus., Proc. vol. 62, art. 19, p. 24, pl. 5, fig. 2. 1923.

Leaves inequilateral, more or less turned to one side, obovate in general shape, 10 to 11 centimeters in length by 3.5 to 7 centimeters in maximum width, rounded above, narrowed below to an acute, wedge-shaped base; margins entire; midrib relatively stout, curved; nervation pinnate, camptodrome; secondary nerves about ten on each side, irregularly spaced and disposed, subtending angles of about 50° with the midrib, soon curving upward, thinning out and coalescing in a series of small loops close to the margin; tertiary nervation poorly defined, the cross nervilles almost straight, or slightly curved or flexed.

[1] Engelhardt, Hermann. Über Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, no. 4, p. 660, pl. 10, fig. 6. 1891.

These leaves are apparently specifically identical with *Crescentia cucurbitinoides* Berry (*loc. cit.*), from the Miocene Tertiary of Southern Mexico—at least I can not discern any character which might serve to differentiate them. The species was referred to the genus *Crescentia* by Berry, through comparison with *C. cucurbitina* L.; but there are several other genera with which it might be about as satisfactorily compared, and I have therefore questioned its unqualified reference to the genus *Crescentia.*

Locality and collector: Trinidad. Porcellanite quarry, Siparia. Van Ingen, April 7, 1921.

BOTANICAL DISCUSSION

The flora described in the preceding pages is exclusively angiosperm and is composed of fifty-four species—using that term in its broadest sense—included in eighteen families and thirty or more genera.

The Monocotyledonae include seven species, of which four are referred to the Arecaceae, two to the Musaceae, and one is not identified, except as a monocotyledone of undetermined generic and family relationship.

The Dicotyledonae include forty-nine species, grouped under sixteen families and thirty-four genera; but the number of the latter might be slightly reduced by the relegation of certain ones to synonymy.

The Choripetalae number thirty-six species, included in twenty-five genera and thirteen families. The two families most extensively represented are the Leguminosae, with eight species included in five genera, and the Moraceae, with seven species included in two genera. The largest genus is *Ficus* with six species.

The Gamopetalae number thirteen species, included in nine genera and three families, of which the Apocynaceae, with eight species included in five genera, is the largest. None of the genera includes more than two species.

Not a trace of the Gymnospermae, the Pteridophyta, or any of the lower classes of plants was found in any of the collections examined.

It would be superfluous to discuss the obvious fact that the flora is typically tropical in its generic elements; but it is of

interest to note that it is essentially an American flora, identical generically and closely similar specifically with that which exists in the West Indian region at the present time.

In the Monocotyledonae the fossil palm remains indicate relationship with the genera *Acrocomia*, *Bactris*, and, possibly, *Sabal*, which are exclusively of New World distribution, and all are native in the West Indies. The natural distribution of the genus *Musa* in our existing flora is exclusively Old World, although it was recorded as in cultivation in the earliest descriptions of the West Indian region; and what were described as silicified remains of banana leaves, apparently of Tertiary age, were recorded from the Island of Antigua by Sylvester Hovey (see the present paper, p. 263). The generic identification of these remains, however, lacks satisfactory confirmation, and it would seem advisable, in the circumstances, to regard the genus *Musophyllum*, to which certain fossil species are referred, as representing merely relationship with the Musaceae rather than actual identity with the genus *Musa*, as previously suggested and discussed in our descriptive text on pages 288 and 289.

If the Dicotyledonae are analysed generically it may be seen that of the thirty-four genera represented in our collections eleven are of cosmopolitan distribution, that is, they are common to both the Old World and the New. These genera are *Ficus*, *Anona*, *Cassia*, *Sophora*, *Dalbergia*, *Ilex*, *Sapindus*, *Zizyphus*, *Eugenia*, *Stylogyne*, and *Mimusops*. All of the others, including *Cussapoa*, *Coccoloba*, *Nectandra*, *Inga*, *Swietenia*, *Clusia*, *Samyda*, *Myrcia*, *Geissanthus*, *Icacorea*, *Bumelia*, *Hancornia*, *Plumiera*, *Cameraria*, *Aspidosperma*, *Bignonia*, and *Crescentia* are exclusively American in their distribution.

We may infer, therefore, that the West Indian Tertiary flora, in its generic elements, was identical with the existing flora of the same region, and that a majority of its specific elements were so closely similar to certain existing species of the islands and the adjacent mainland of North America, Mexico, Central America, and South America that it is almost impossible to differentiate between them; and some of these would be regarded as specifically identical if such identification could be considered as justified, based upon surficial leaf characters alone.

Evidently the flora of the region has undergone very little change or modification during the entire period of time that has

elapsed since the Tertiary flora flourished there, and this indicates, conclusively, that climatic conditions must have been uniform throughout the same period and practically the same as those that now obtain in the region.

EXPLANATION OF PLATES

Plate 1 (Trinidad)

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Fig. 1. *Cassia sipariensis* n. sp. Siparia 303
Fig. 2. *Musophyllum trinitense* n. sp. Siparia 288
Fig. 3. Monocotyledone of uncertain systematic affinities. Siparia 290
Fig. 4. *Palmocarpon bactrioides* n. sp. Siparia 286

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Plate 3 (Trinidad)

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Fig. 3. *Anona saraviana* Berry? Guajataca River 298
Figs. 4, 5. *Aniba portoricensis* n. sp. Guajataca River 300
Figs. 6, 7. *Myrcia eugenioides* n. sp. Collazo River 310
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PLATE 10 (Porto Rico)

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FIG. 3. *Sophora* (?) *suspecta* n. sp. Collazo River 304
FIG. 4. *Cassia* (?) *dubiosa* n. sp. Collazo River 304
FIG. 5. *Plumiera evidens* n. sp. Collazo River 315
FIG. 6. *Stylogyne* (?) *fragmenta* n. sp. Collazo River 313
FIG. 7. *Inga pseudonobilis* n. sp. Collazo River 301
FIG. 8. *Pithecolobium pseudotrapezifolium* n. sp. Collazo River 302

PLATE 11 (Porto Rico)

FIGS. 1, 2. *Aspidosperma collazoense* n. sp. Collazo River 317
FIG. 3. *Apocynophyllum pseudowillughbya* n. sp. Collazo River 318
FIG. 4. *Pithecolobium vexativum* n. sp. Collazo River 303
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FIG. 6. *Hancornia minor* n. sp. Collazo River 316
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PLATE 12 (Porto Rico)

FIGS. 1–3. *Laurophyllum dubiosum* n. sp. Collazo River 300
FIG. 4. *Psidium* (?) sp. Collazo River 311
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FIGS. 3, 4. *Mimusops jumuriensis* n. sp. Matanzas 314
FIG. 5. *Zizyphus* sp. Matanzas 307
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PLATE 15 (Cuba)

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FIG. 5. *Bignonia sensibilis* n. sp. Santa Clara 319
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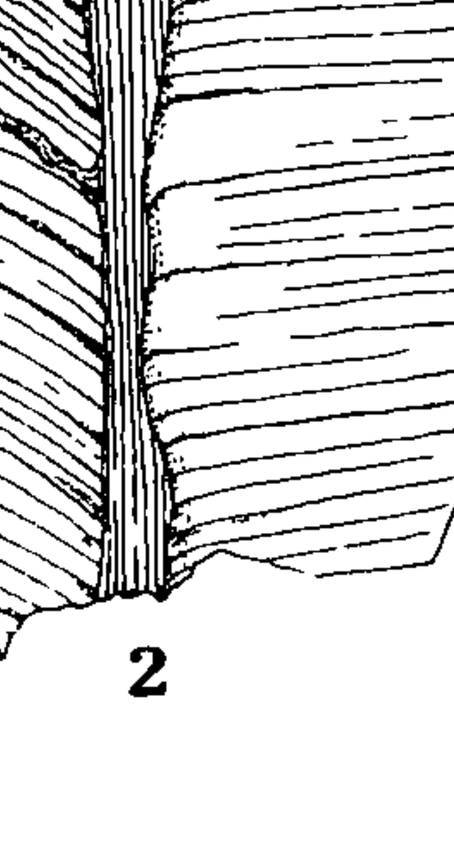
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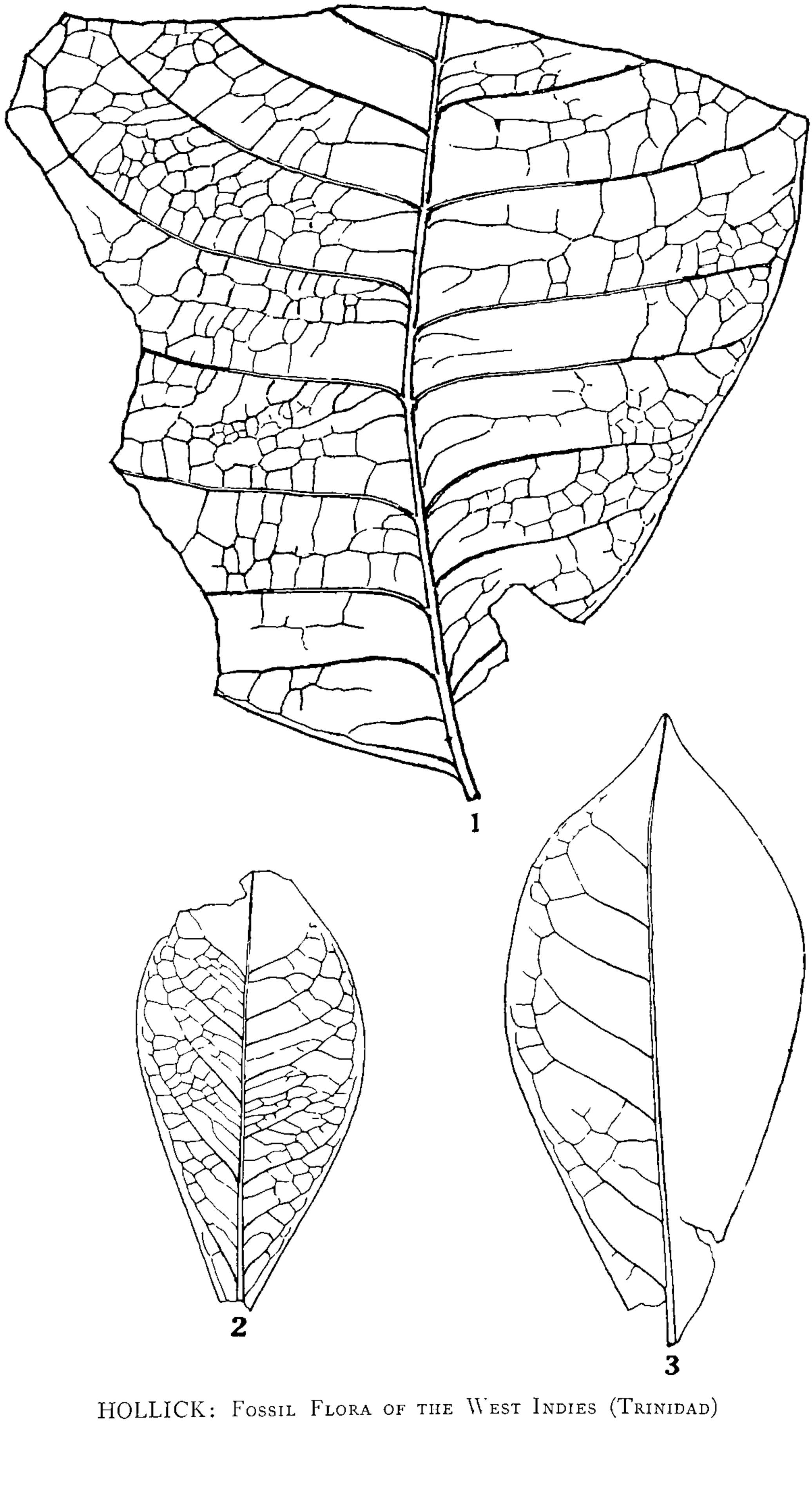


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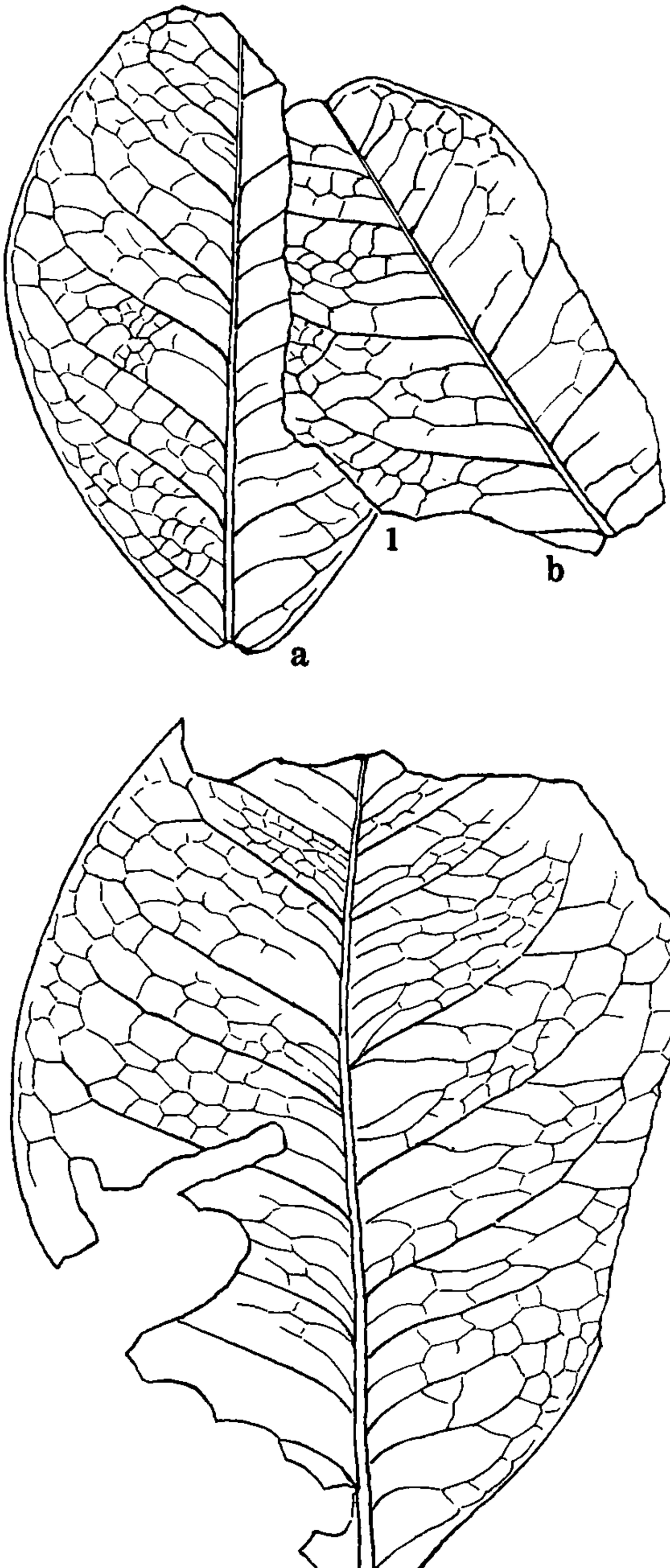


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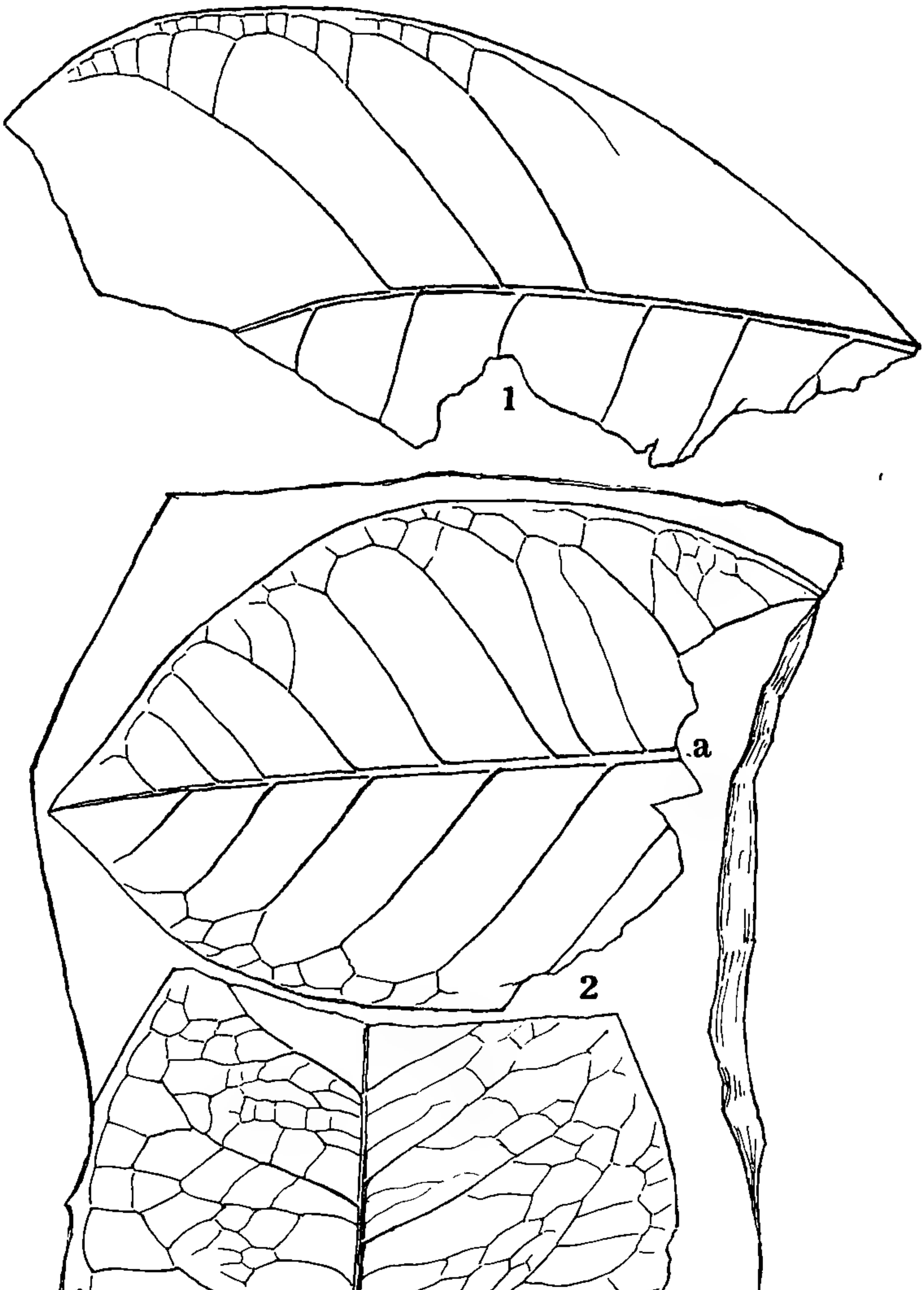
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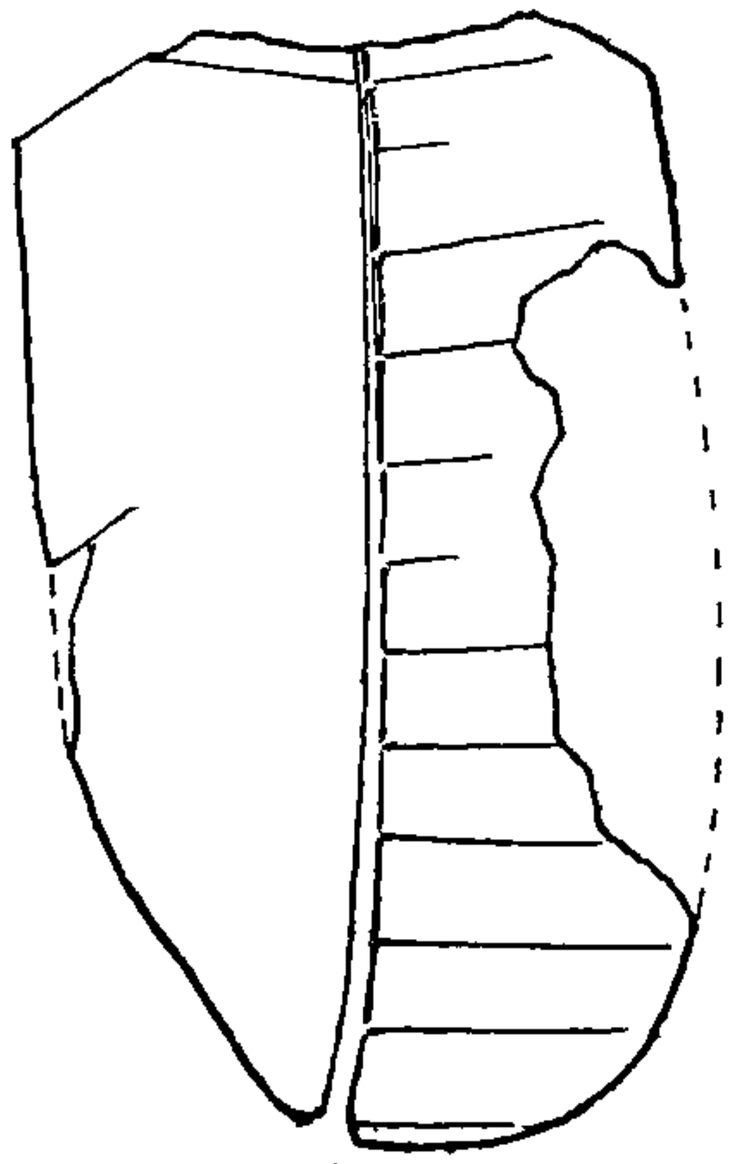
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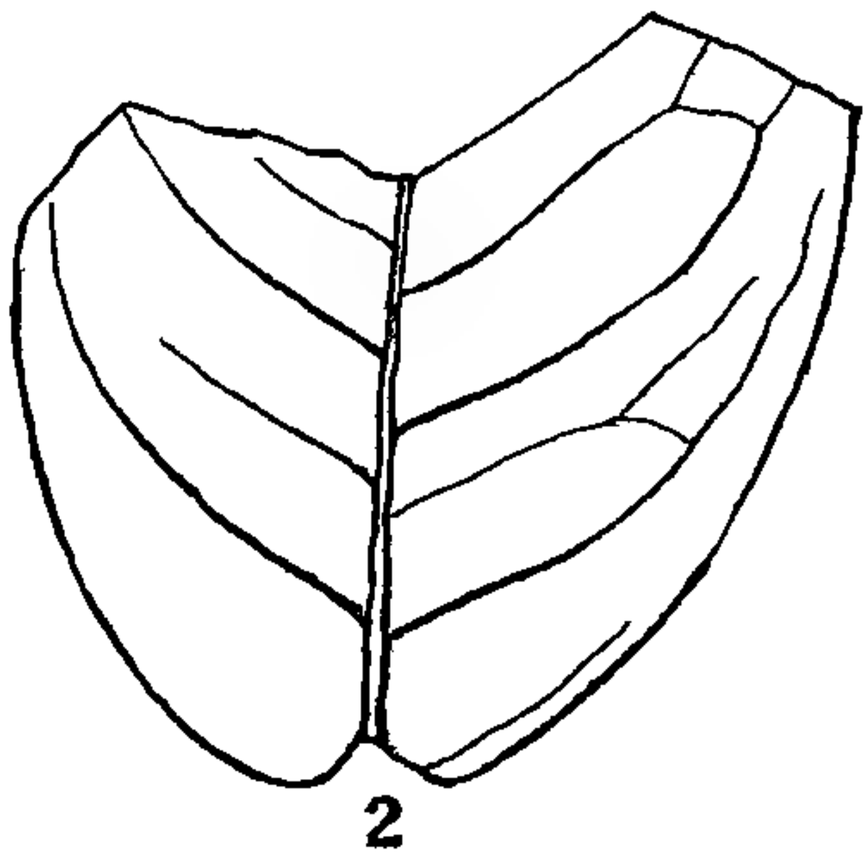
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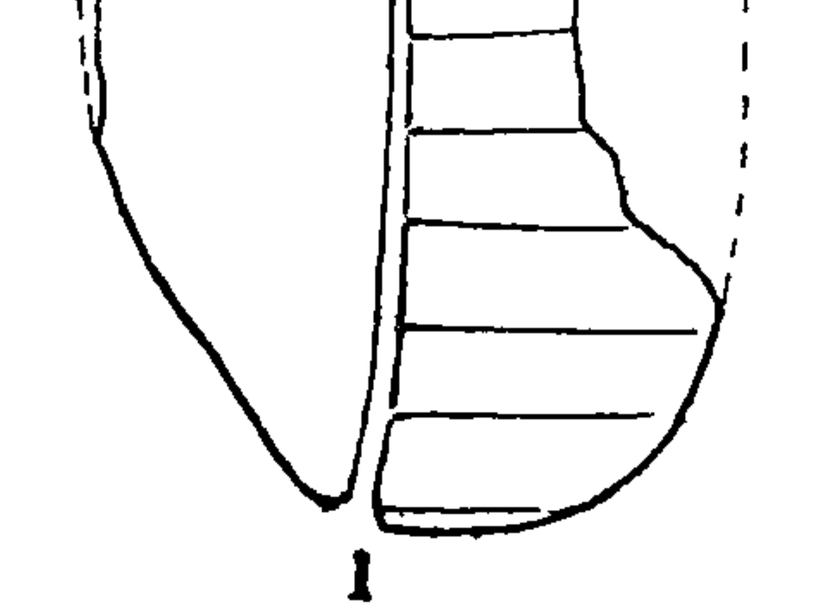
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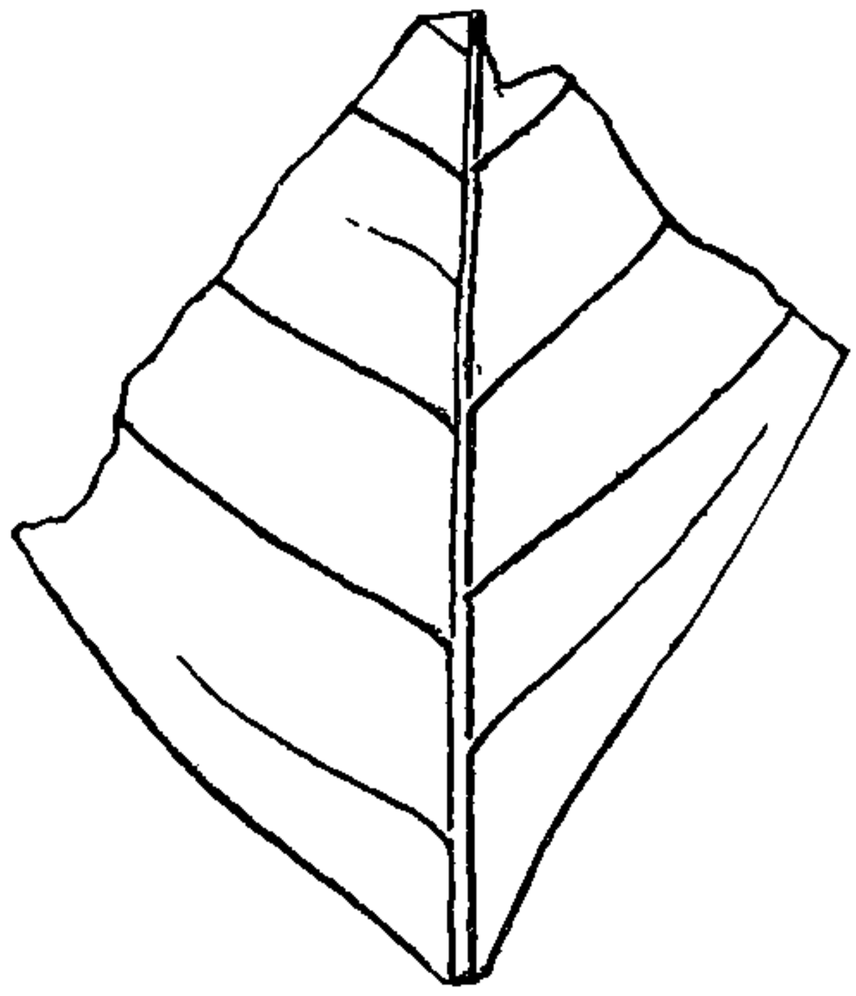
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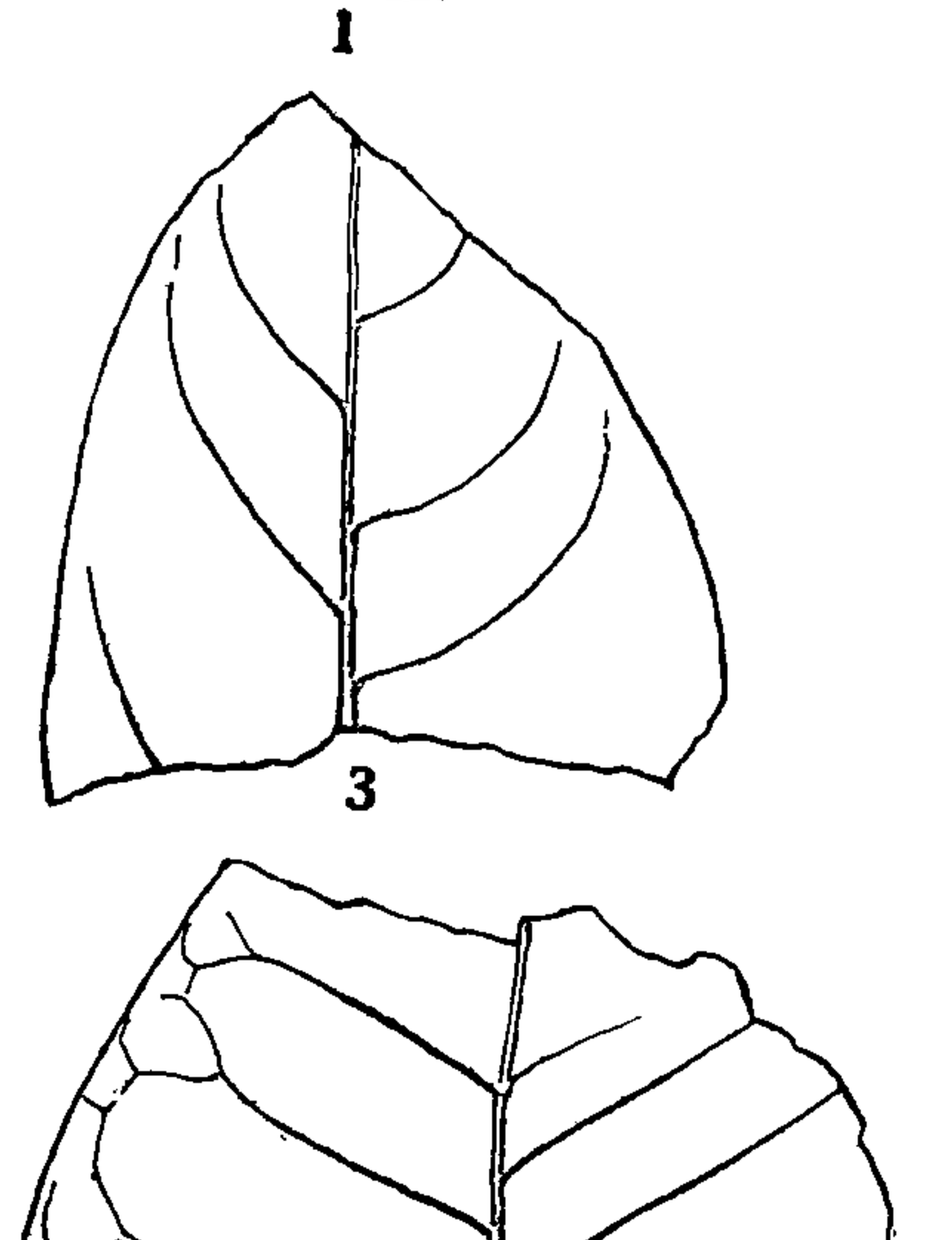
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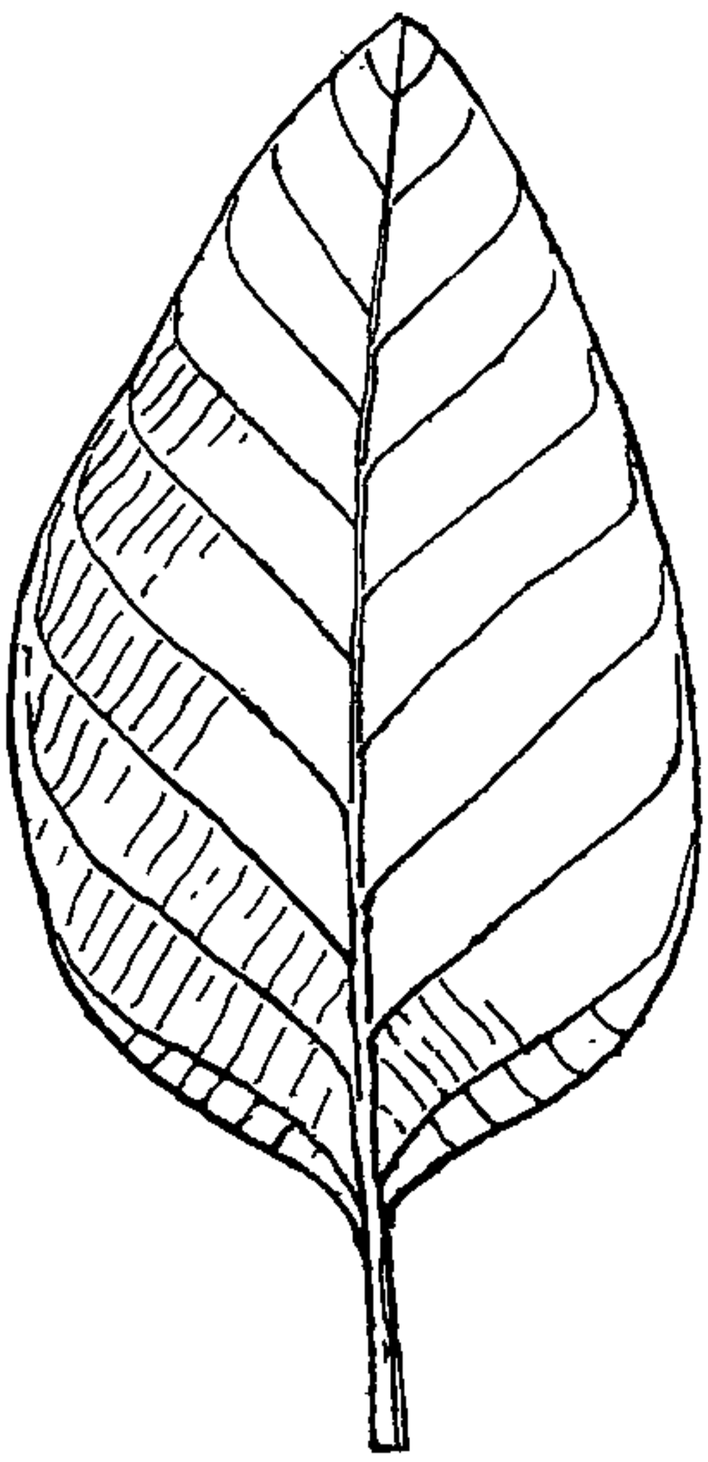


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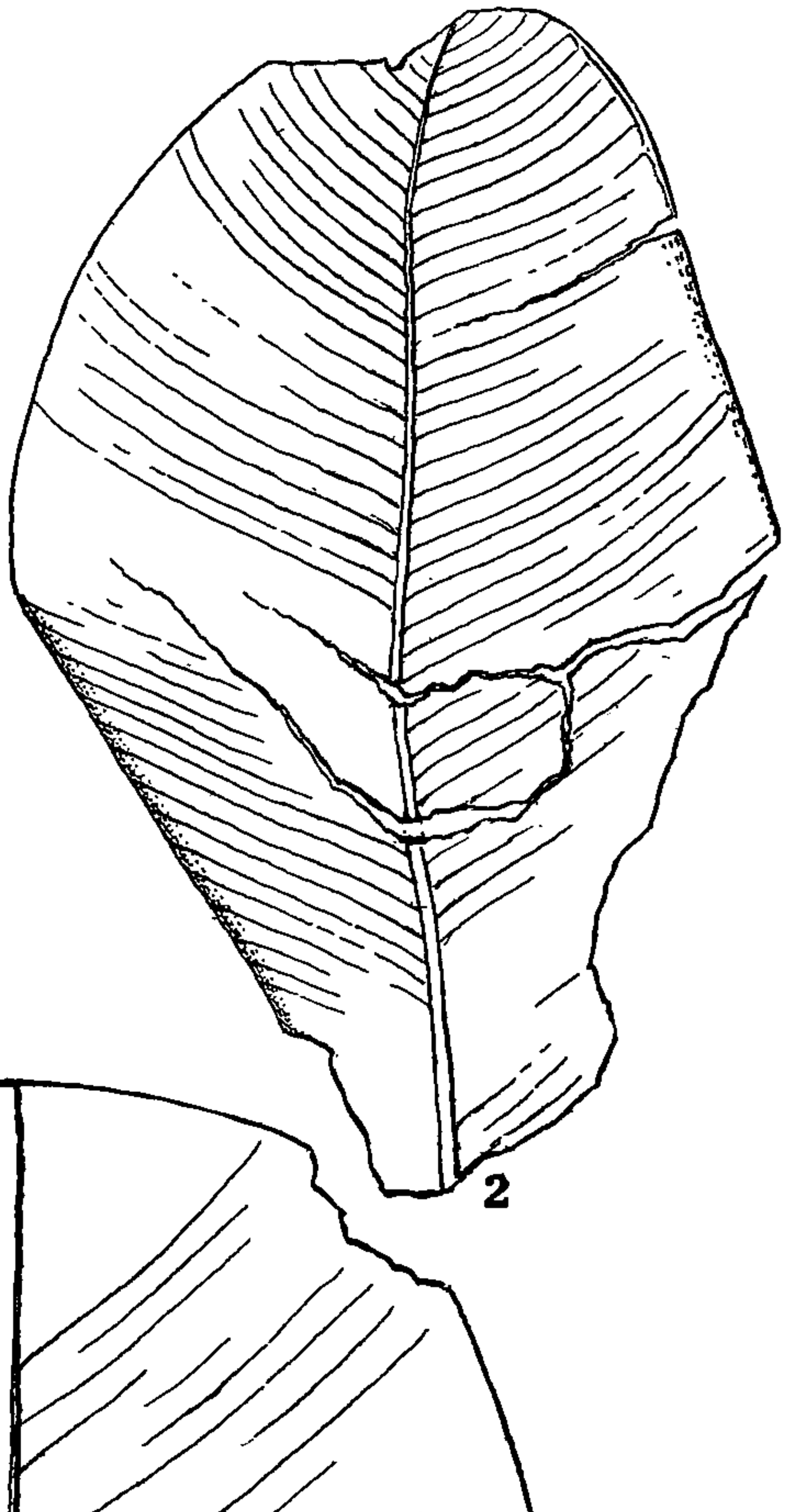


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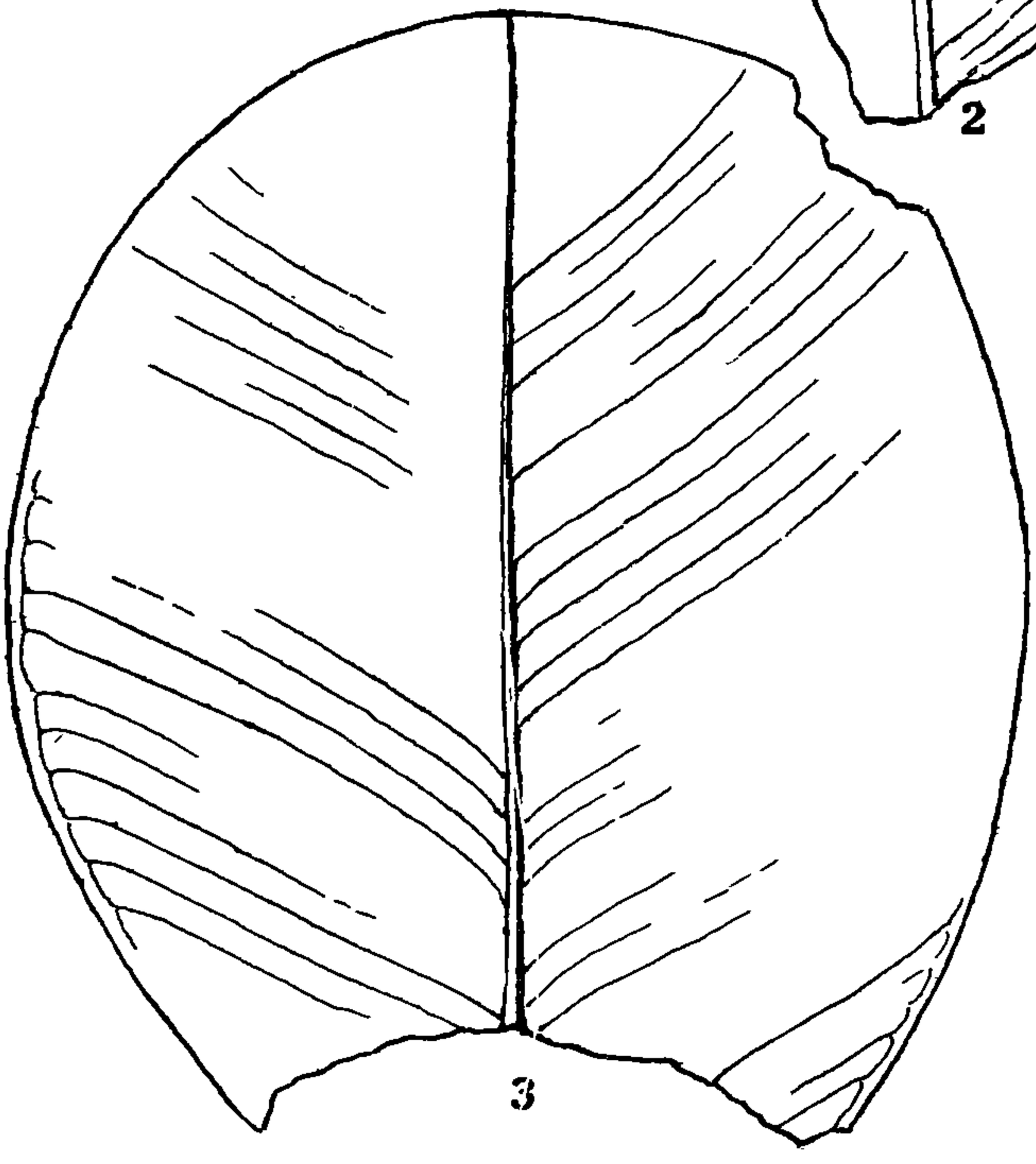
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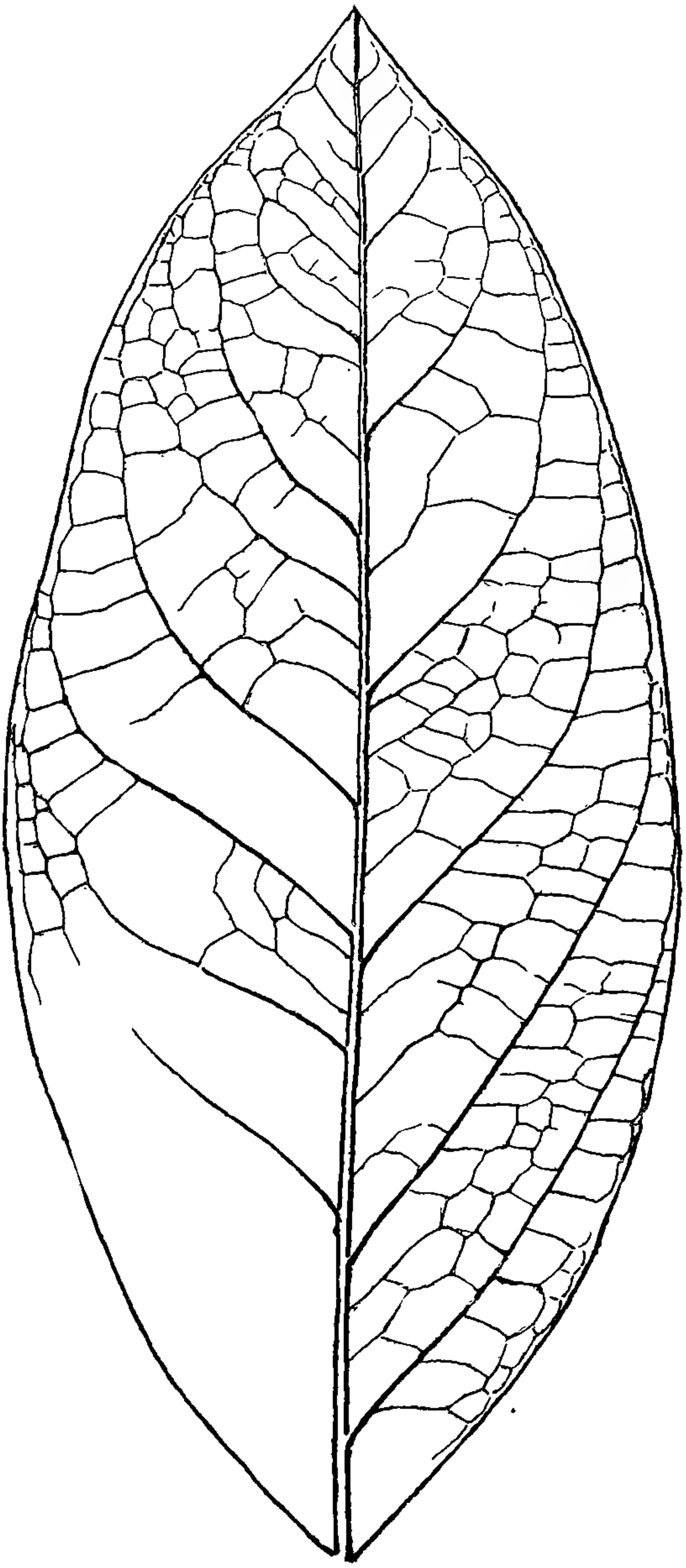
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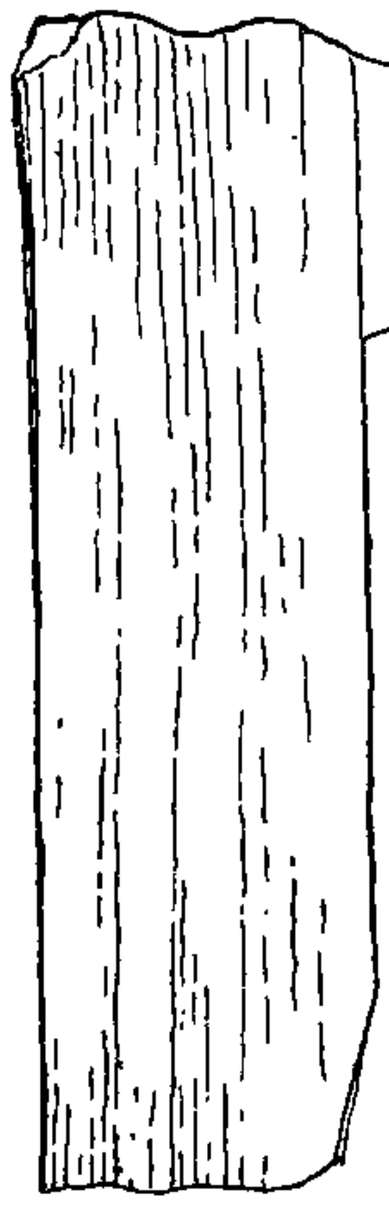


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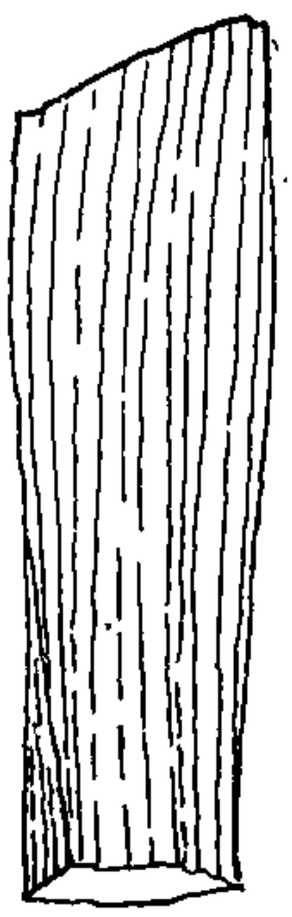


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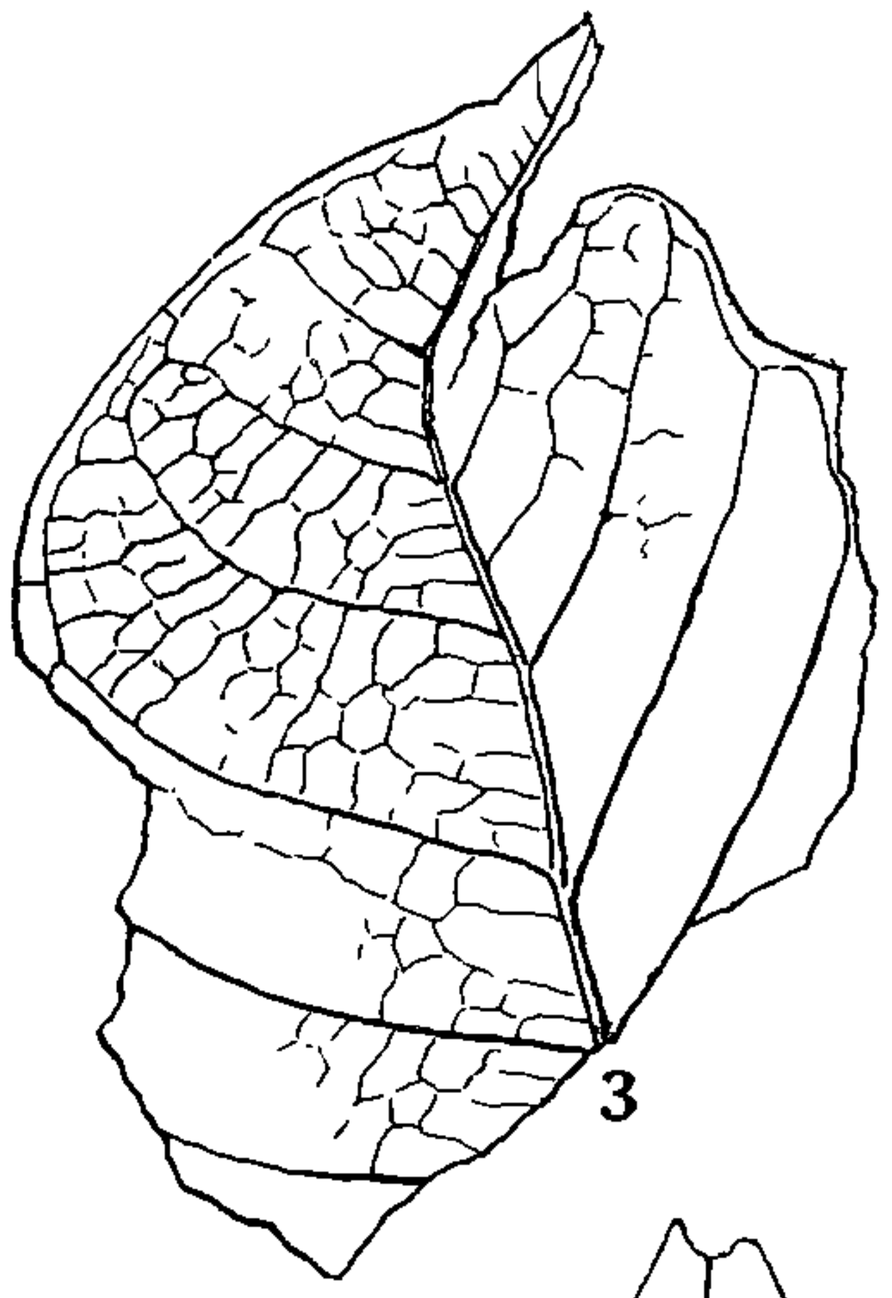
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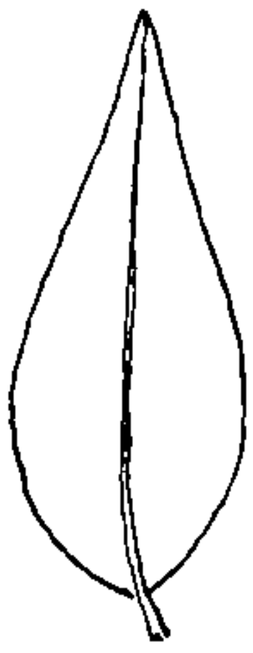
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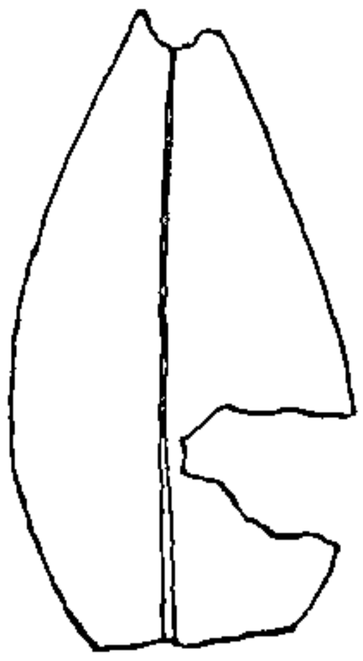
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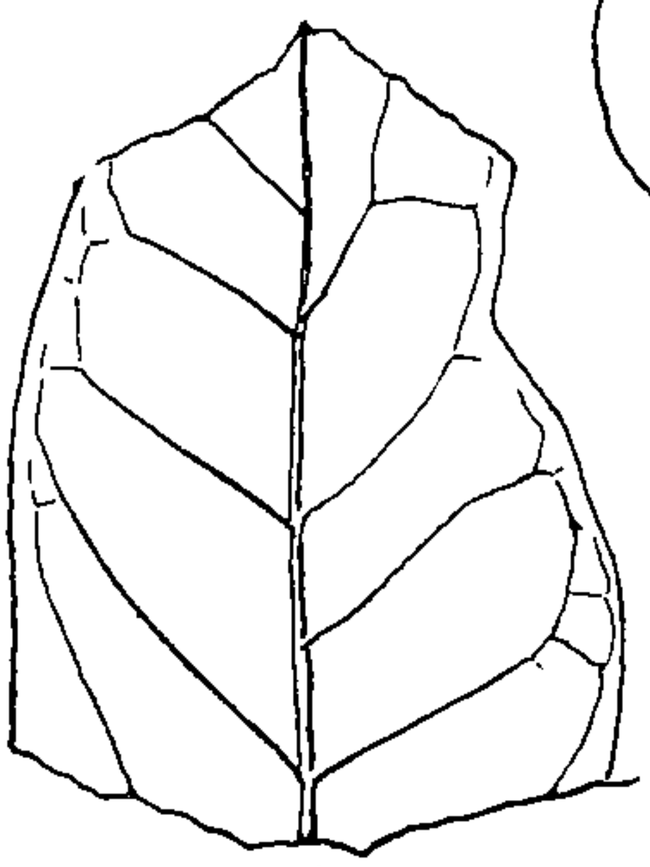
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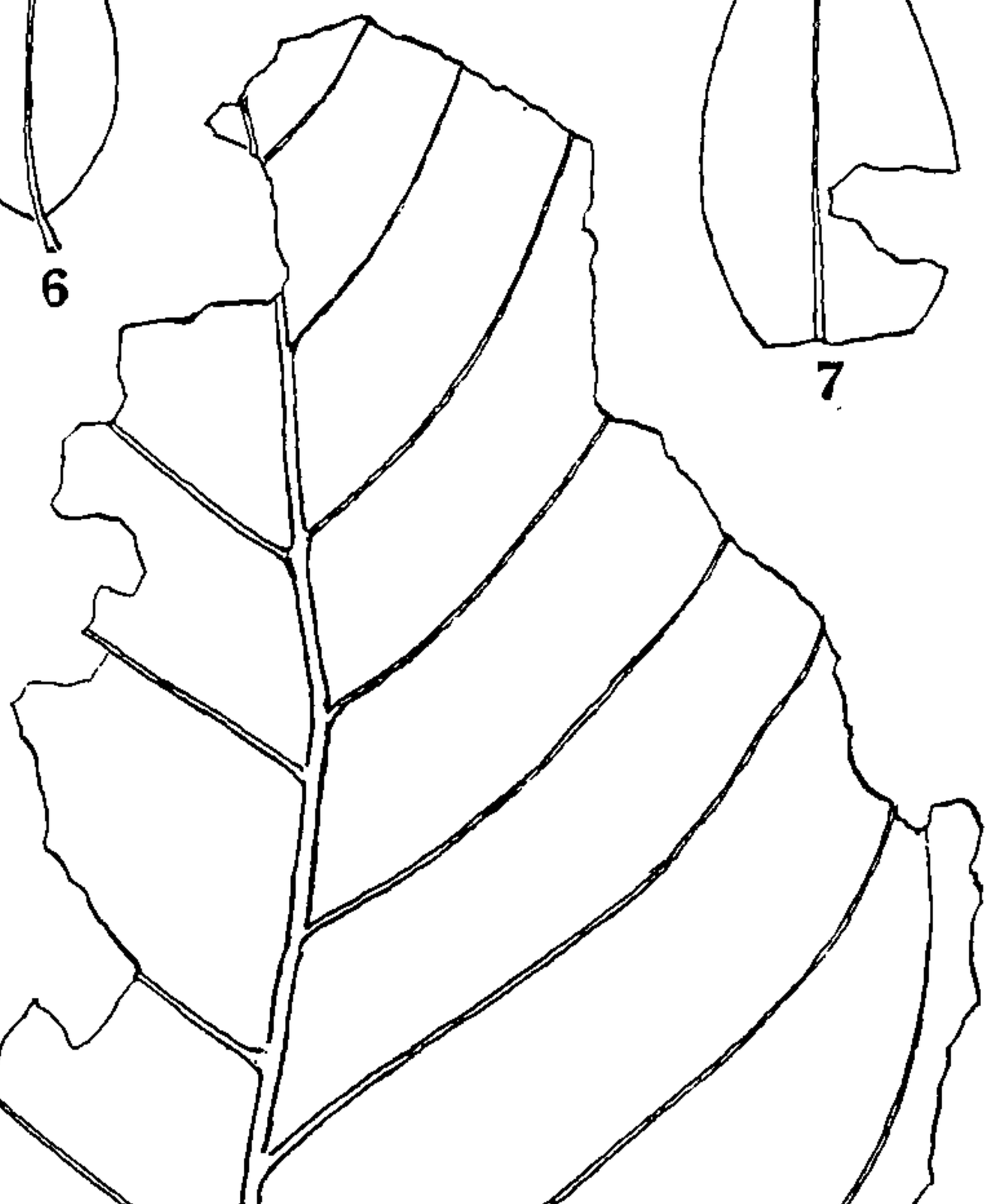
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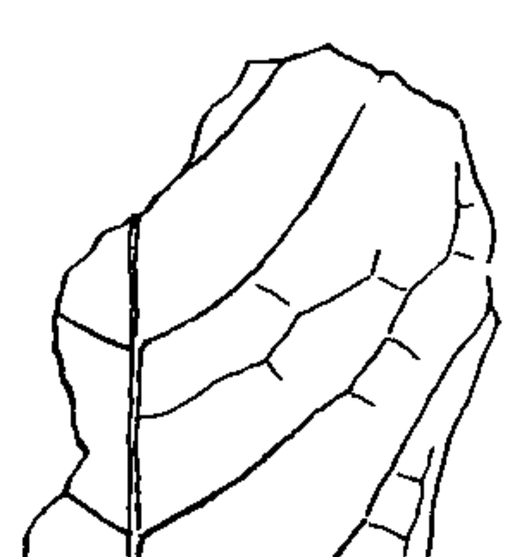


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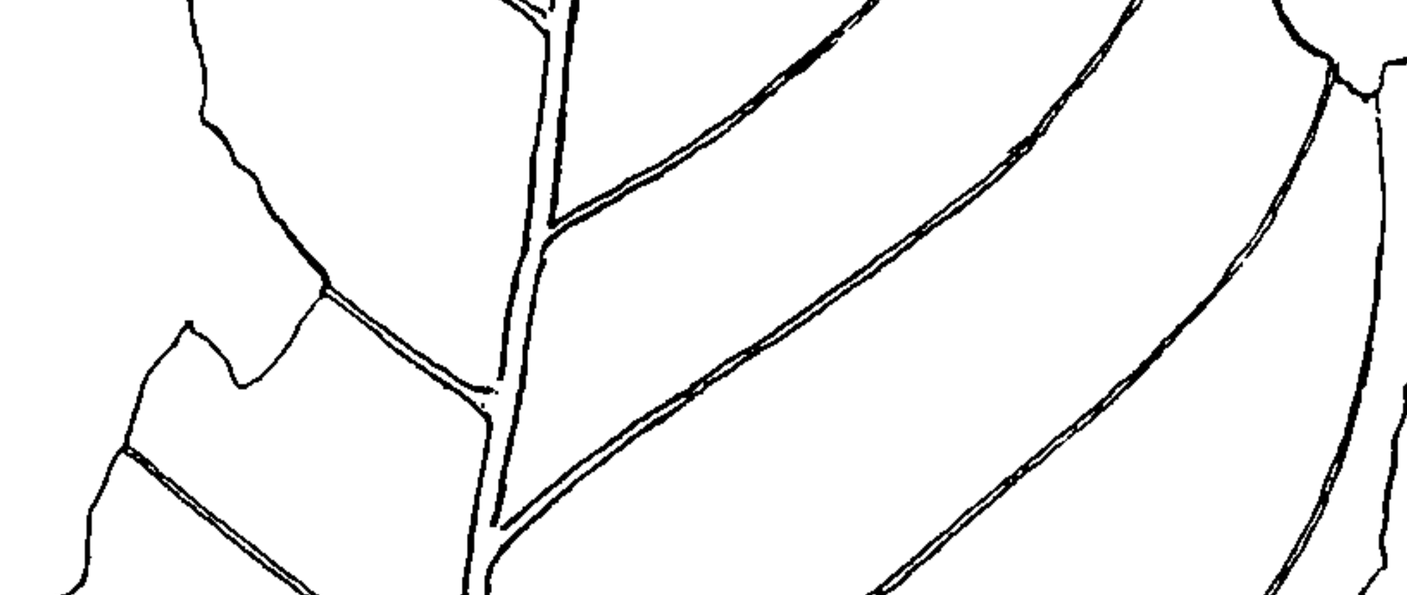


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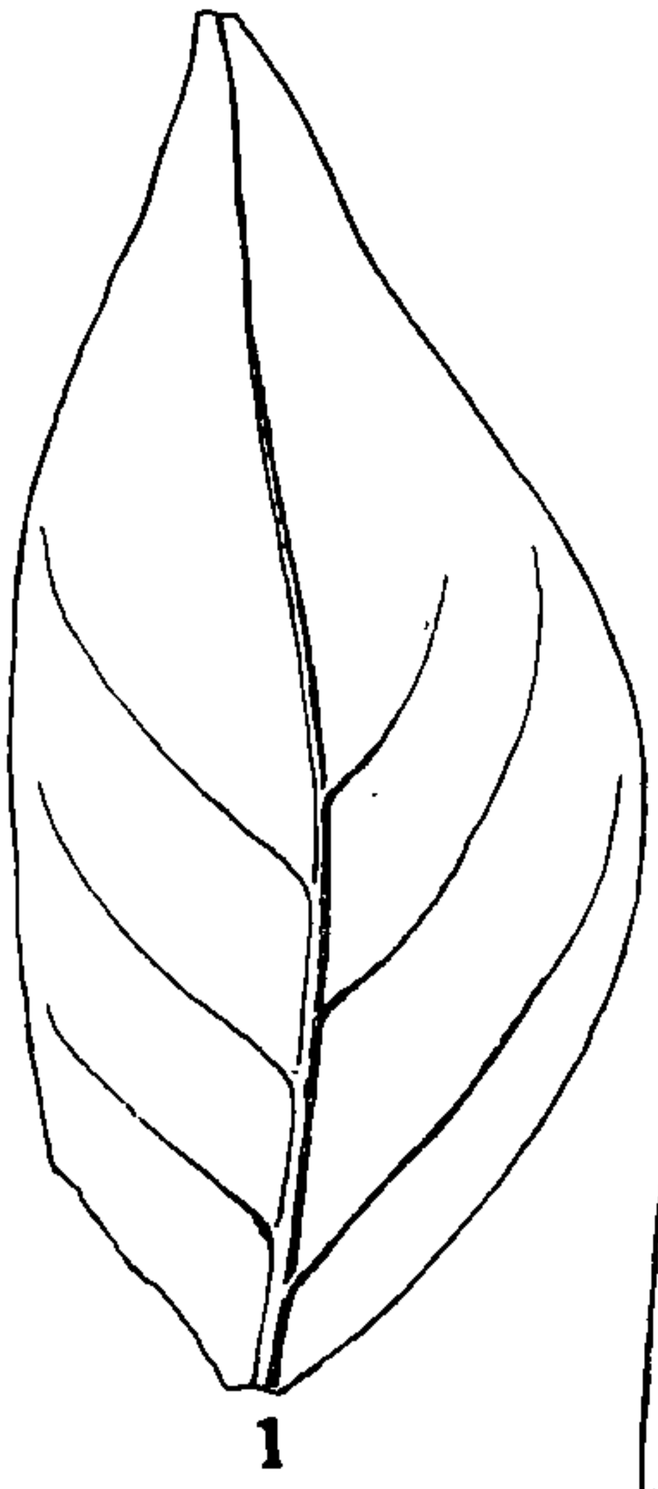


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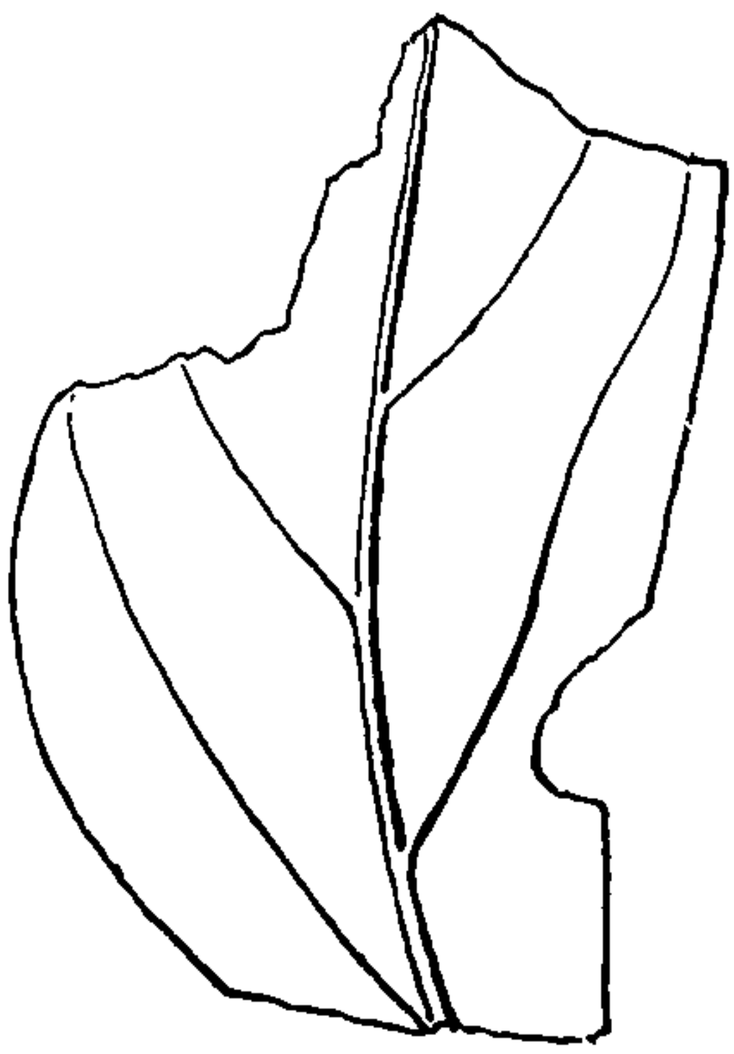


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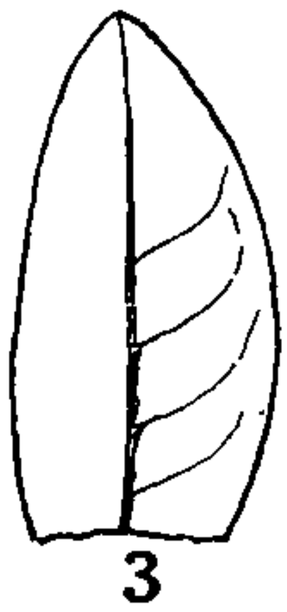
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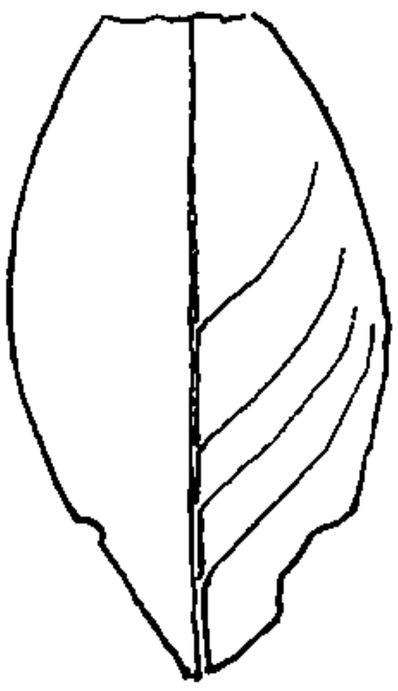
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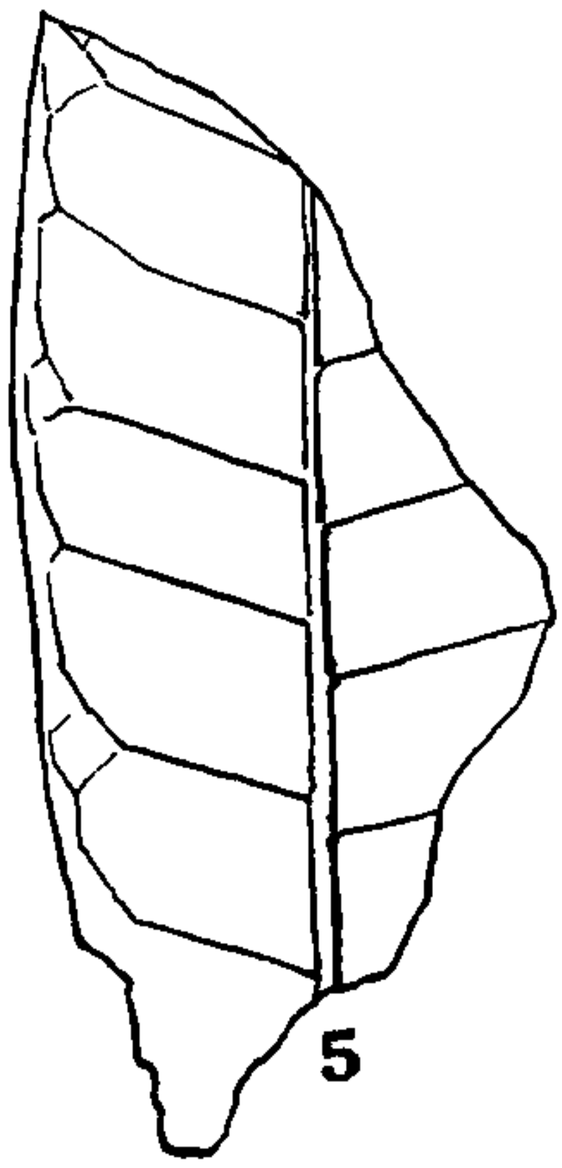
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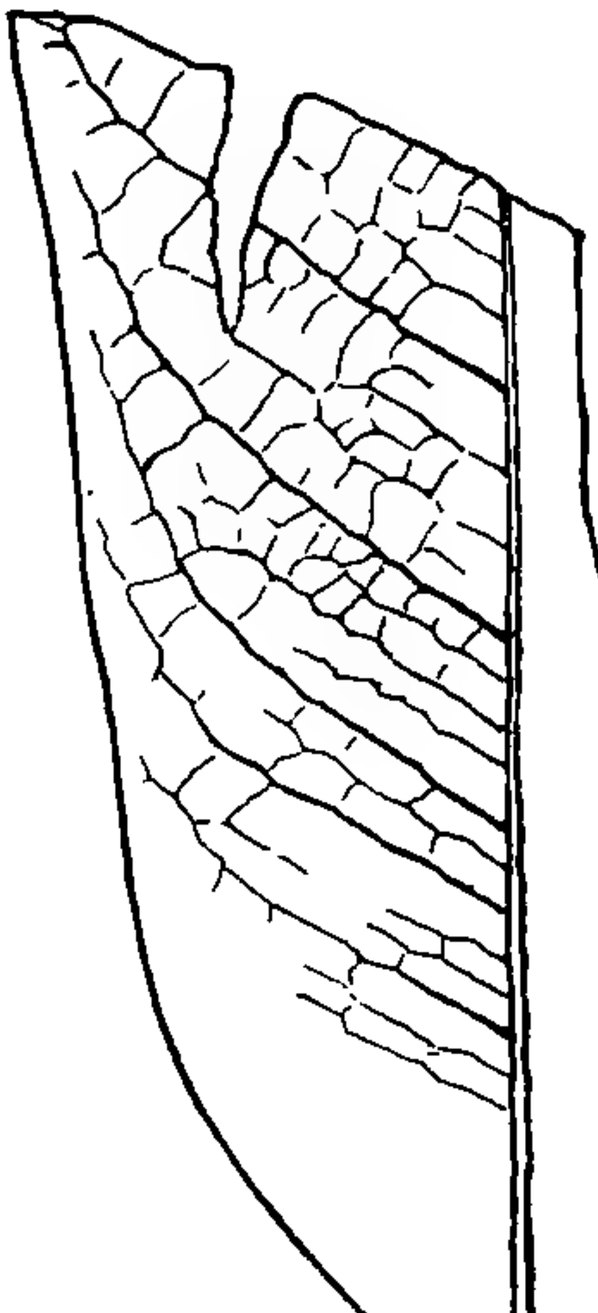
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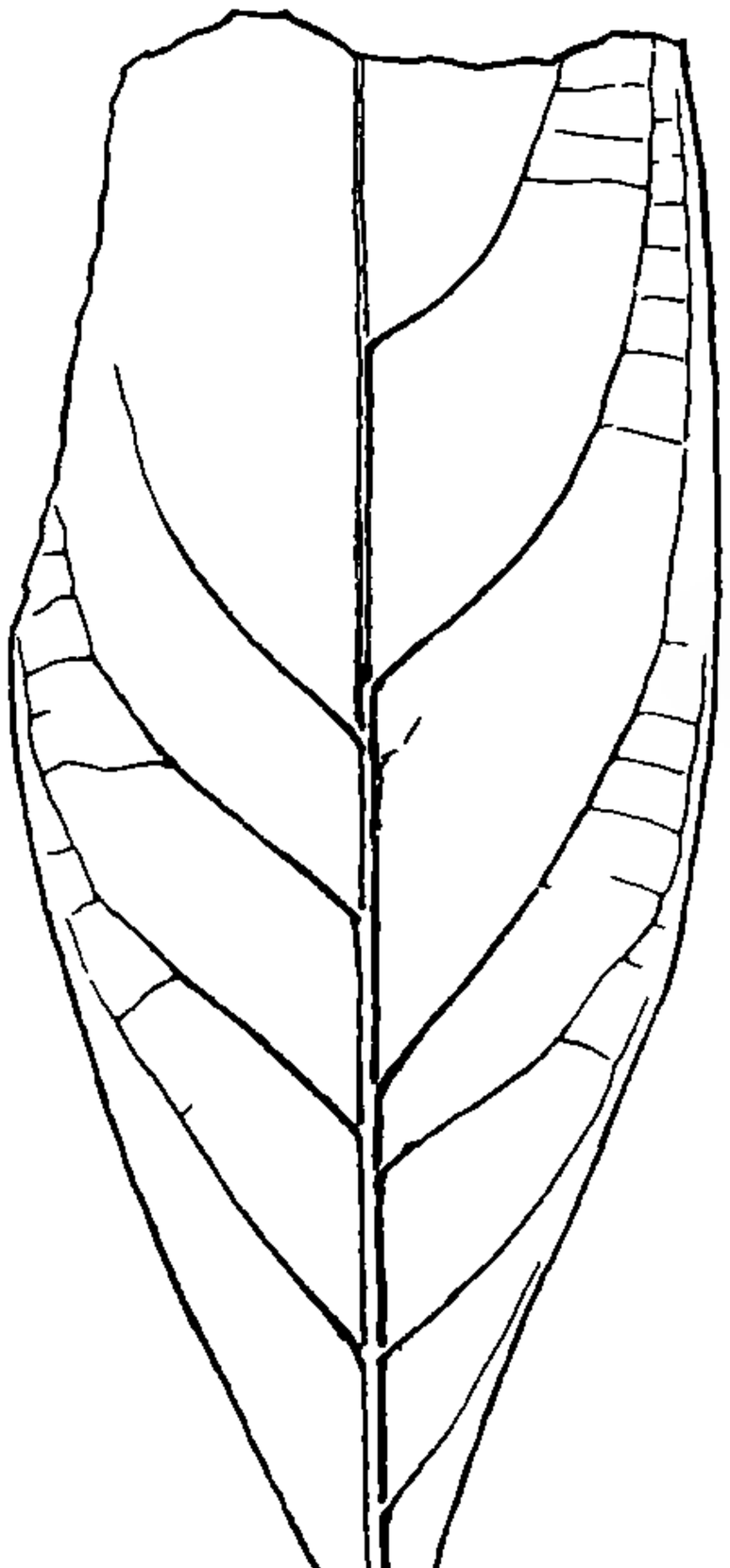
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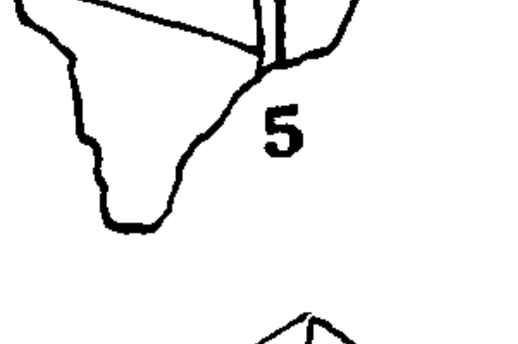
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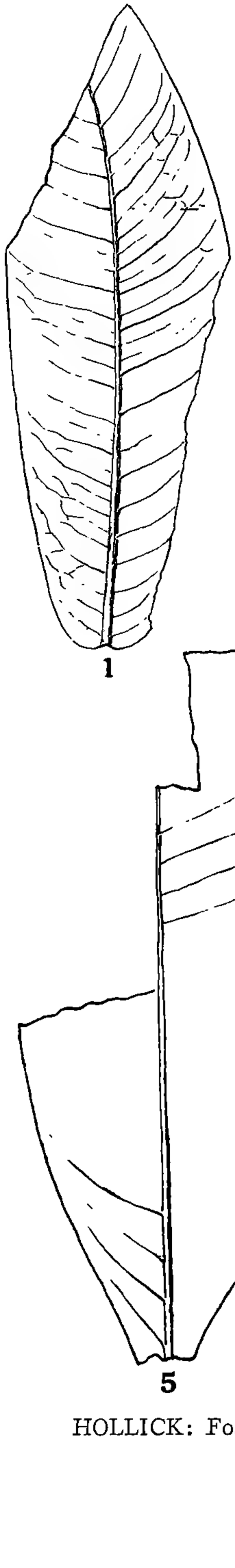


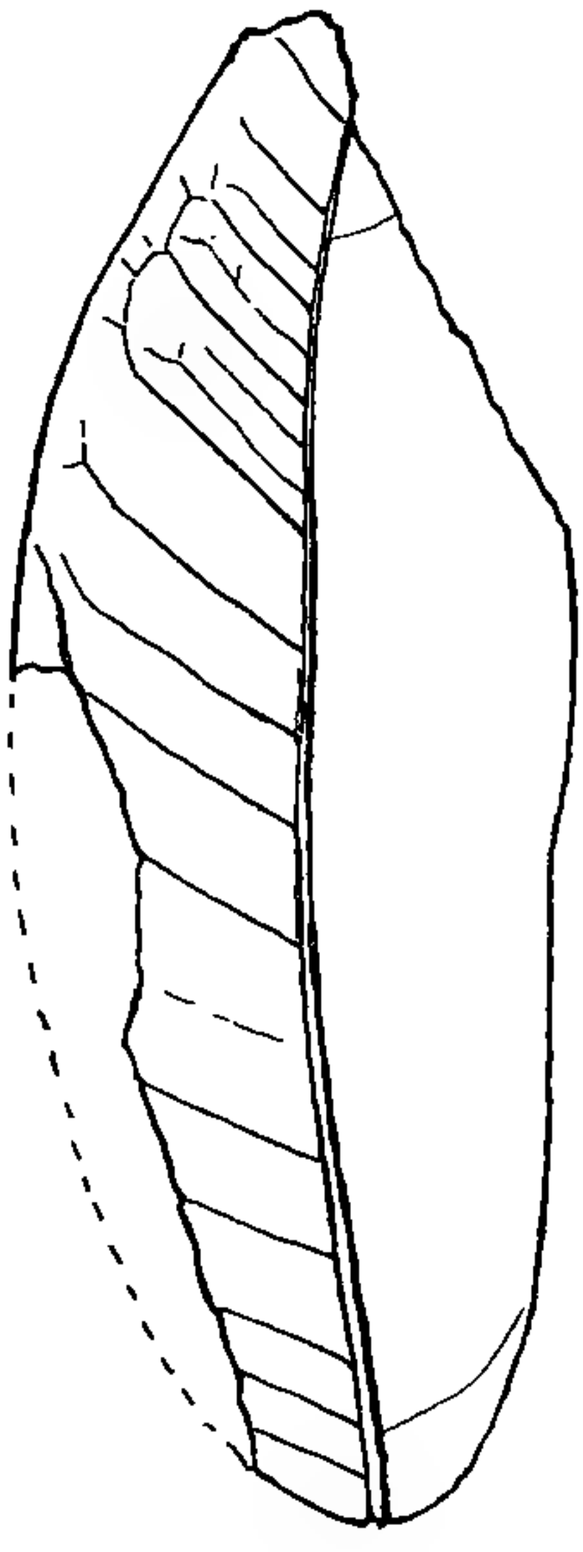
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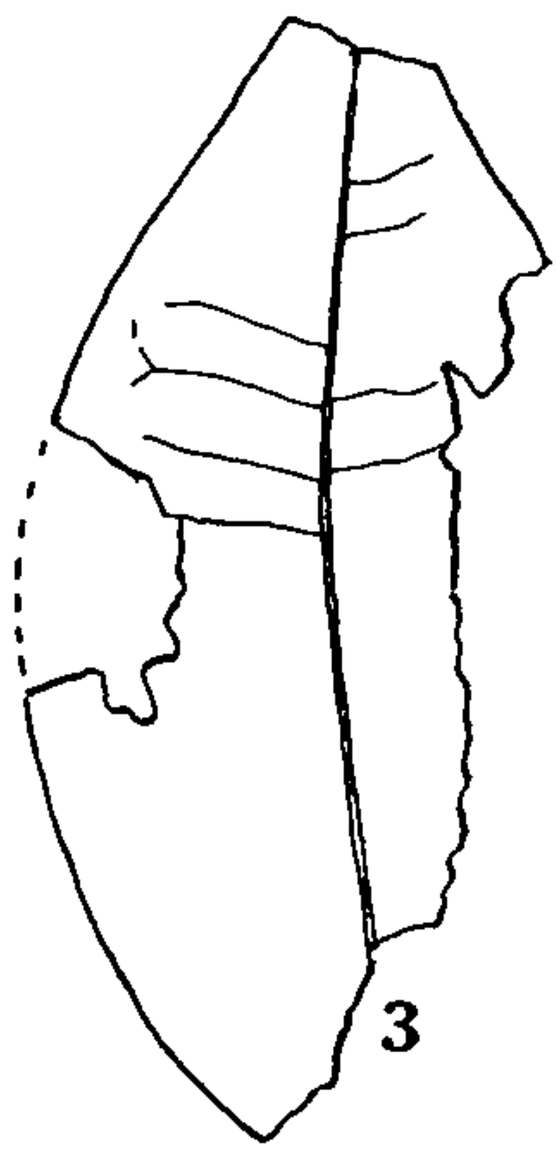


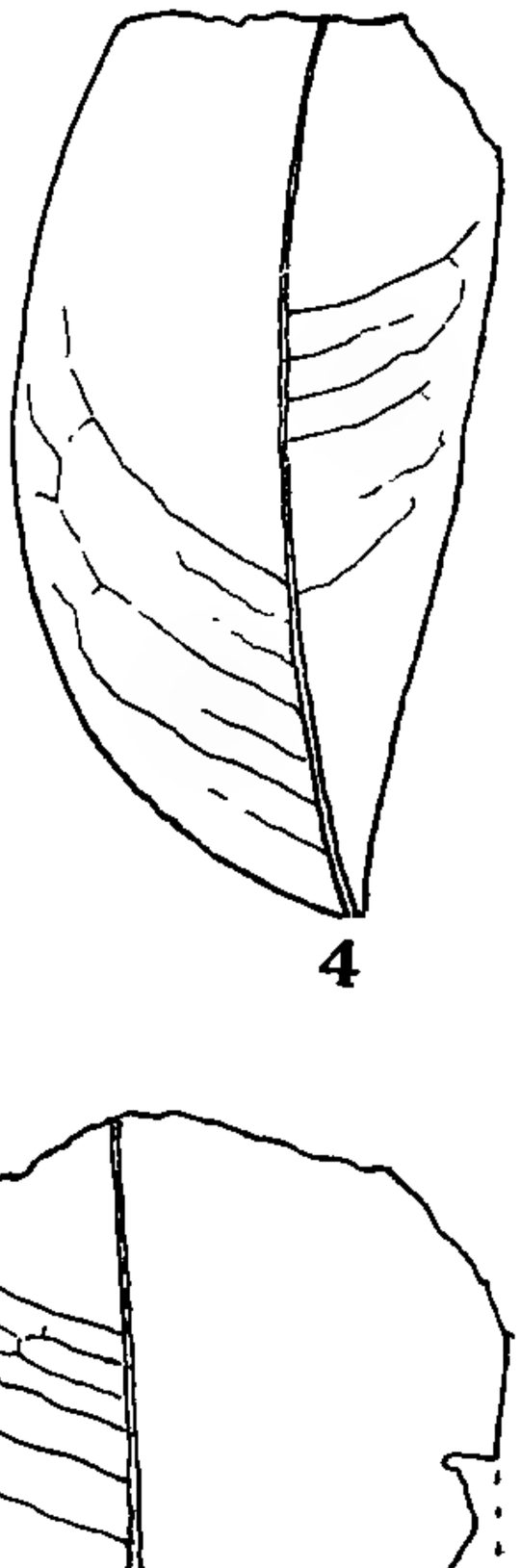
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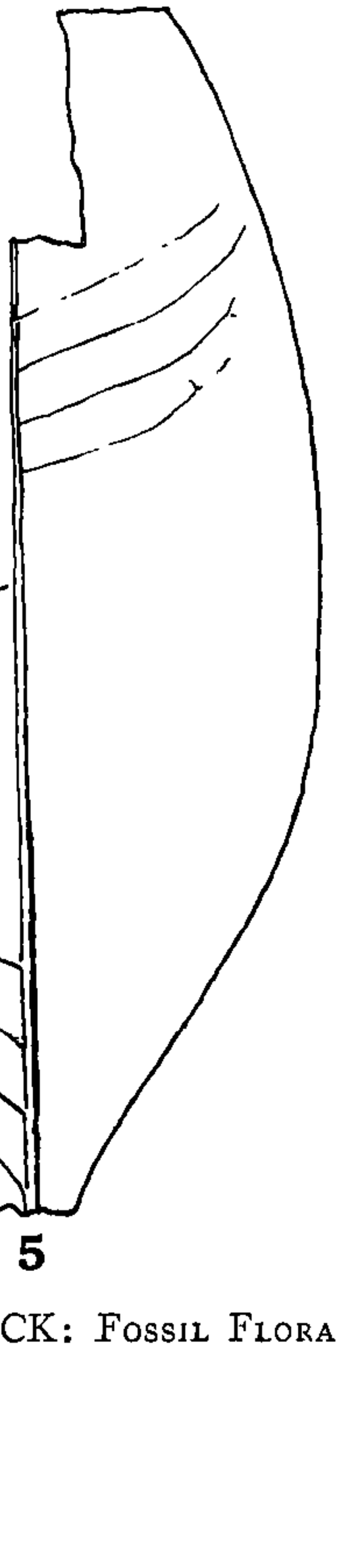
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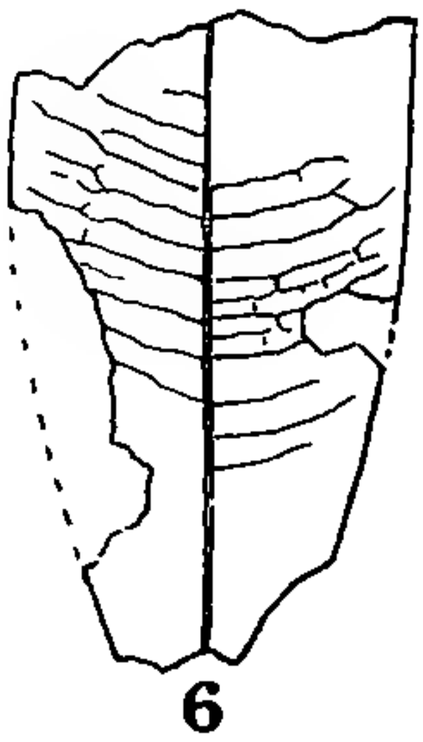

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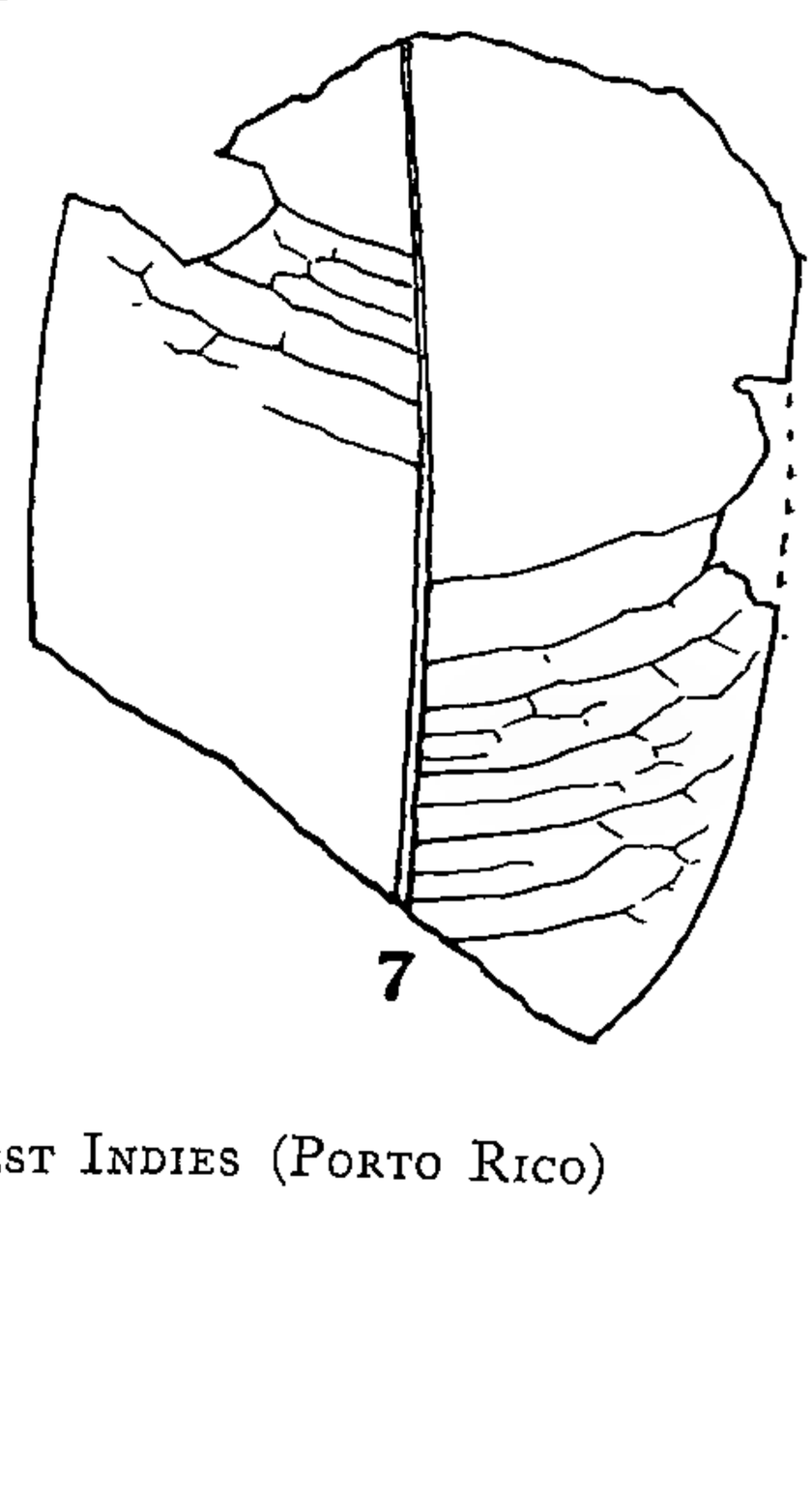

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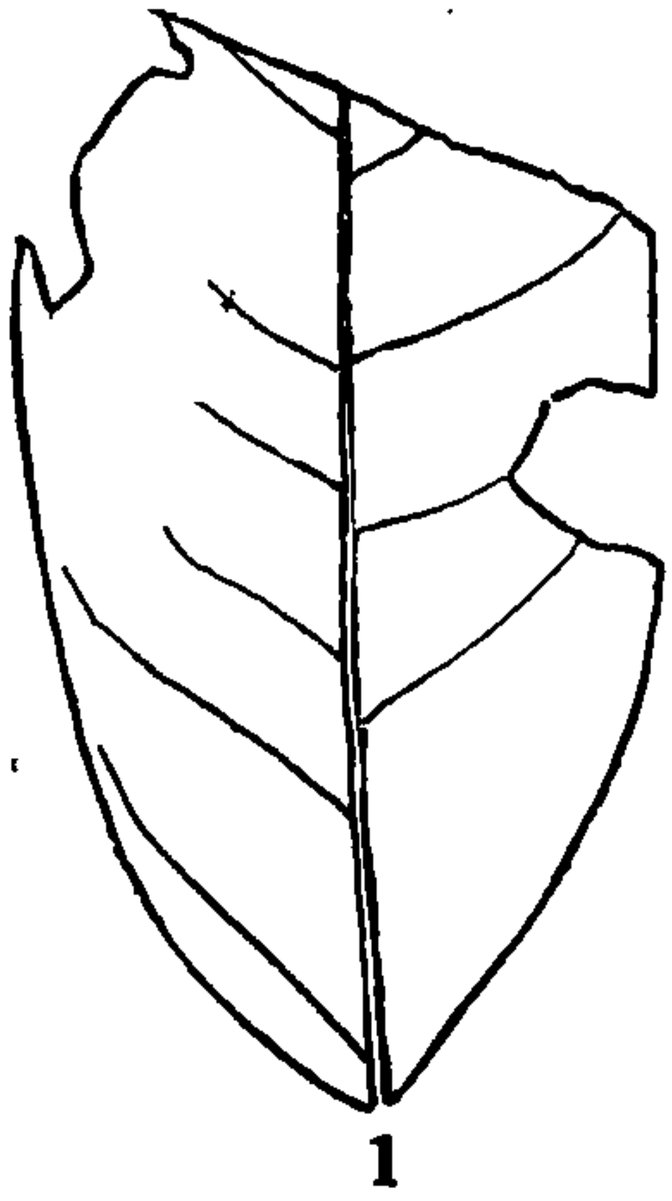

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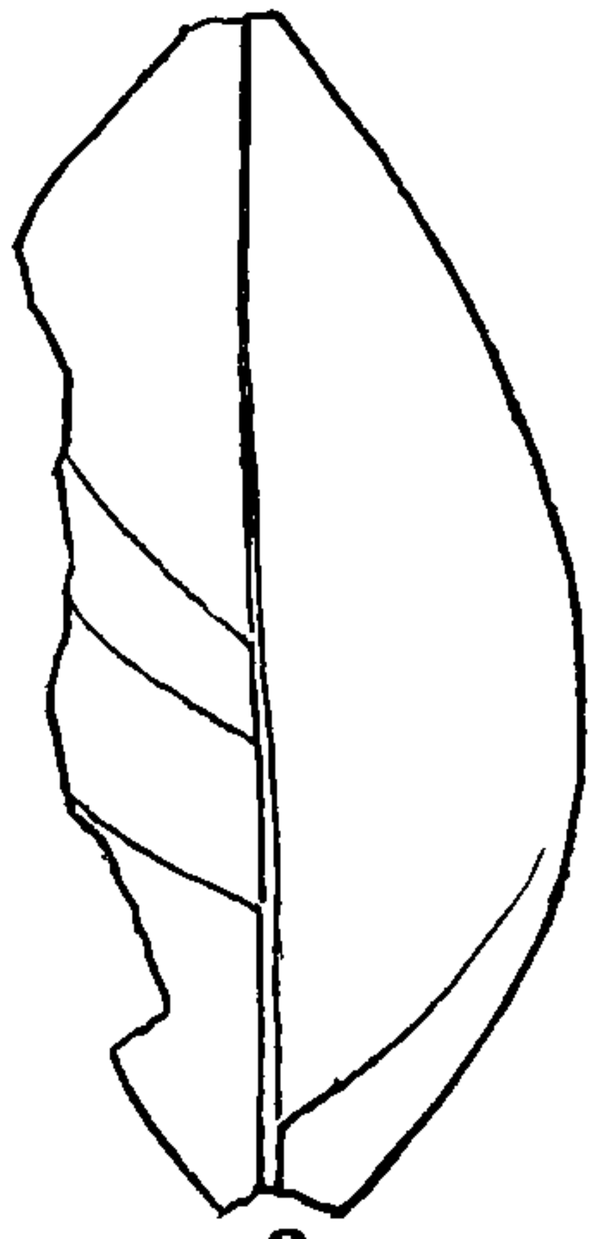

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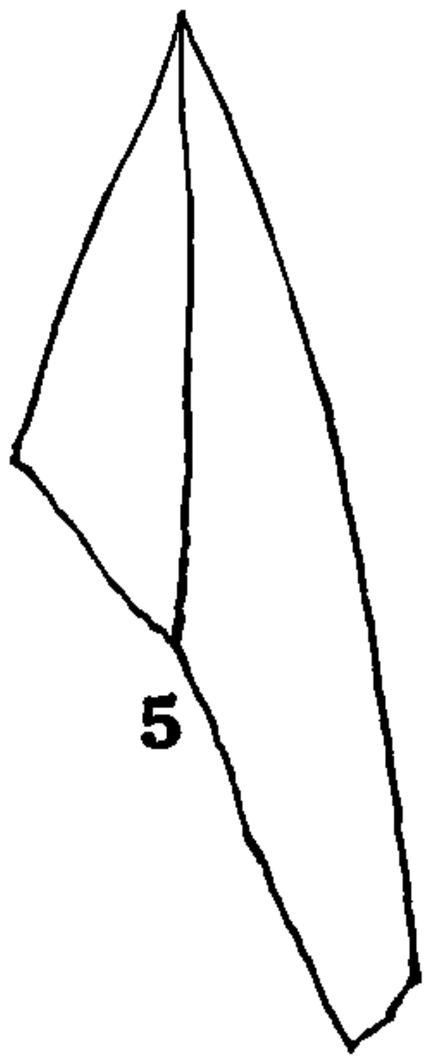
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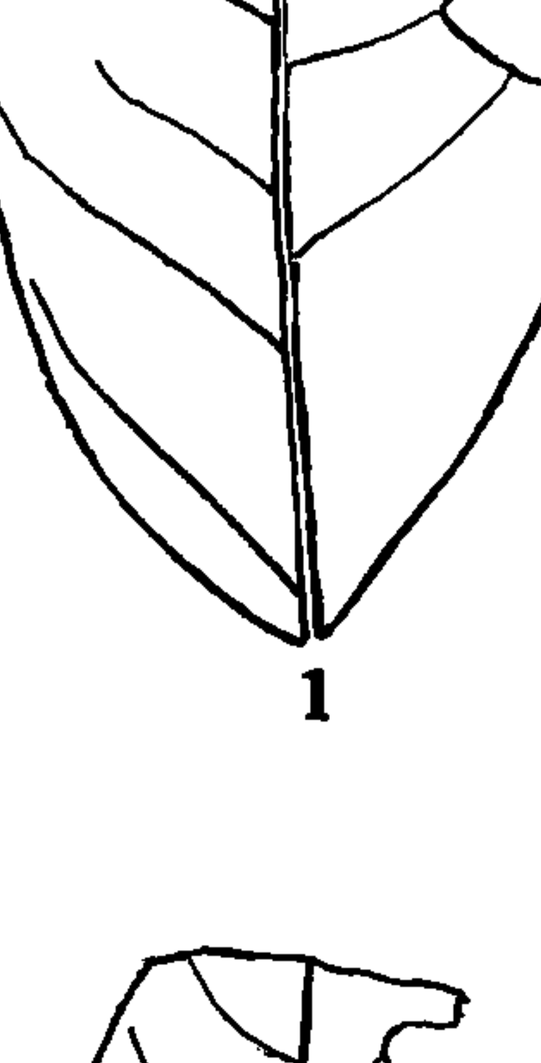
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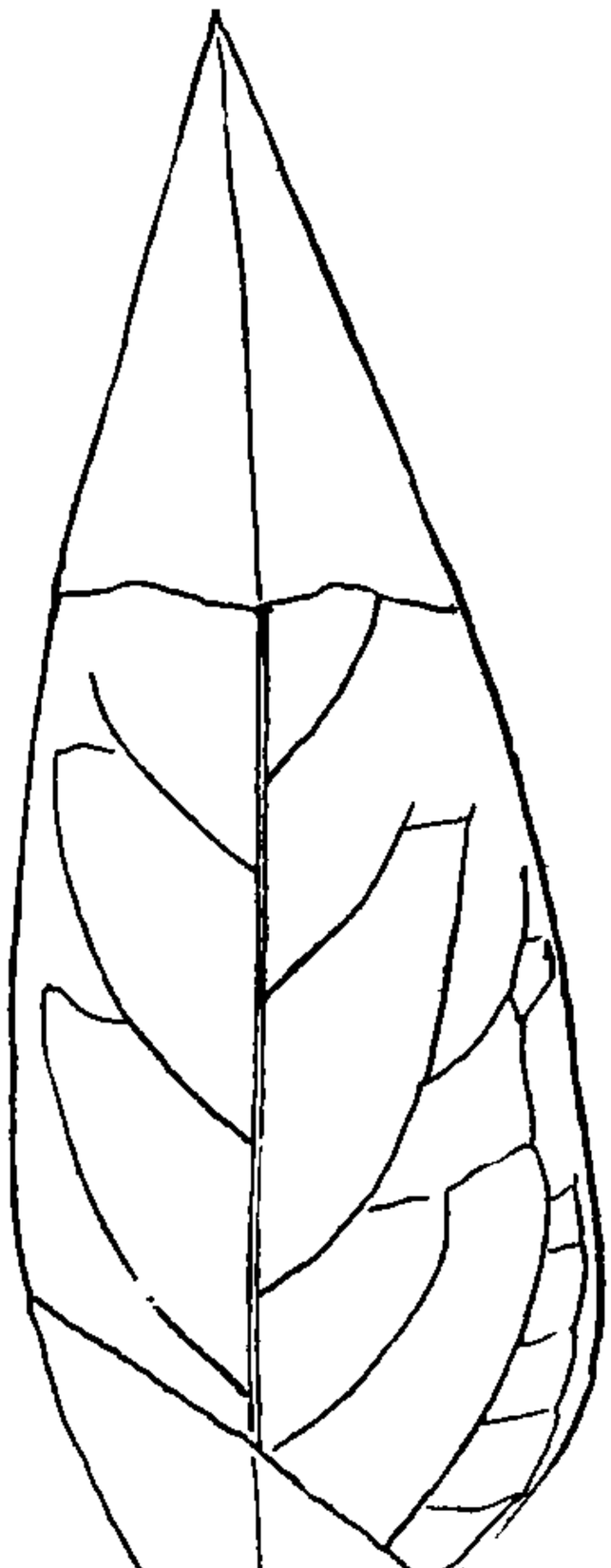
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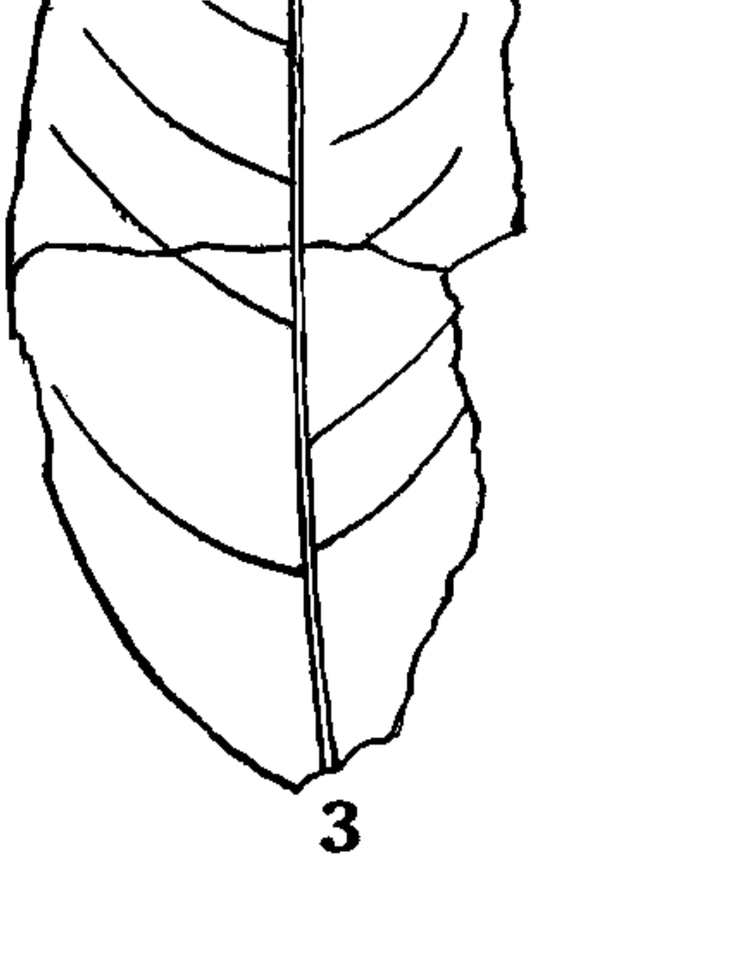


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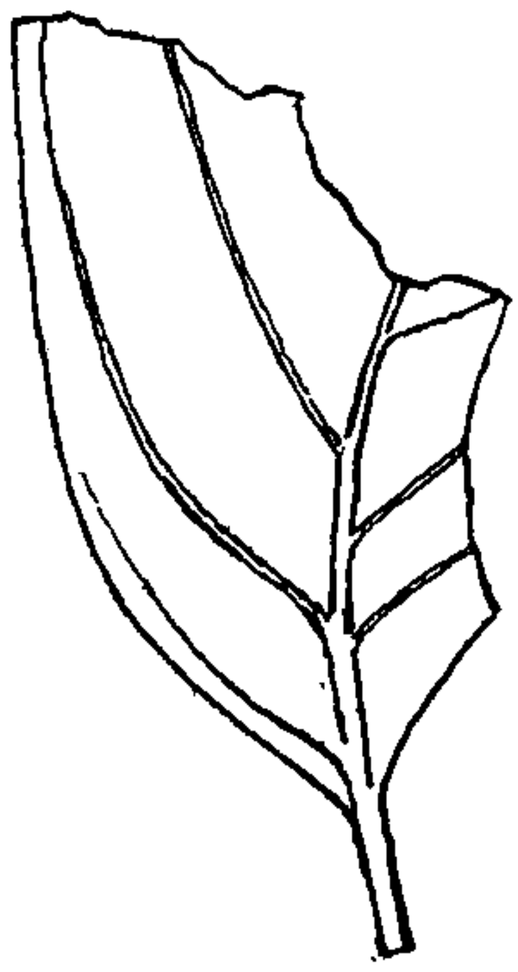




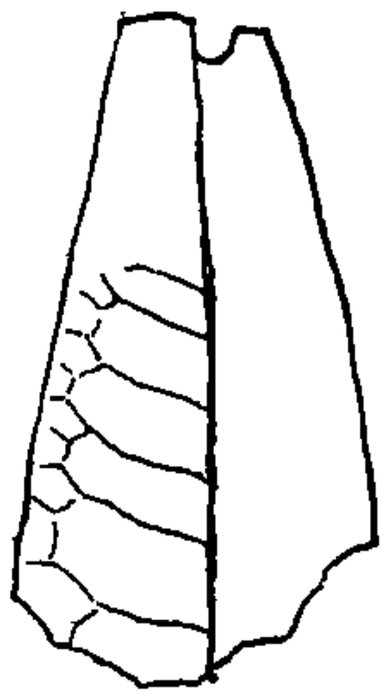
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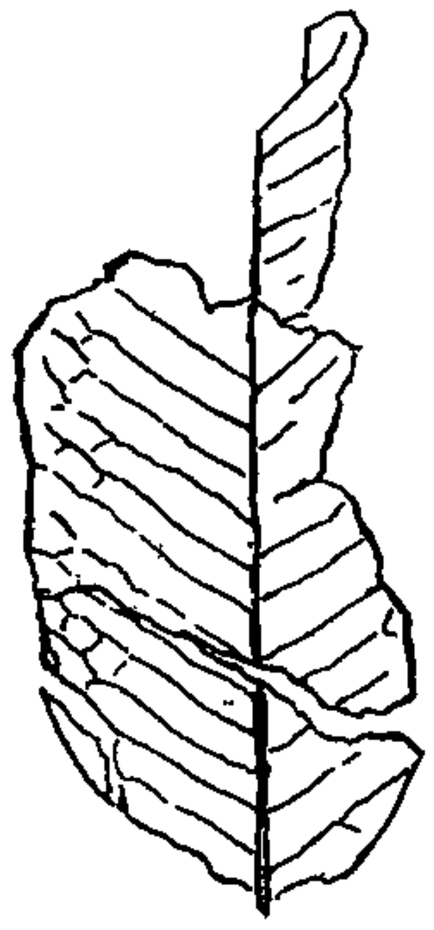
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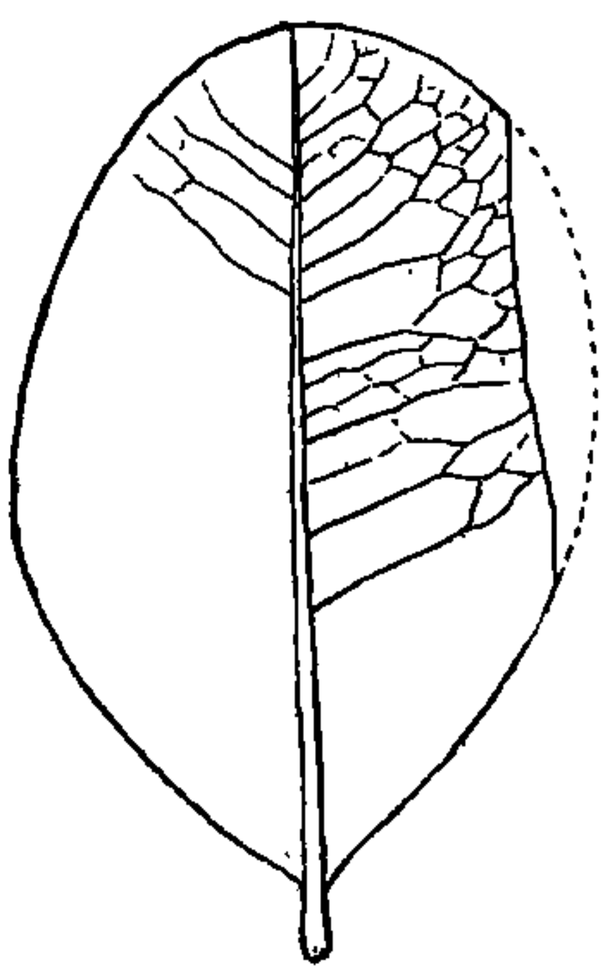


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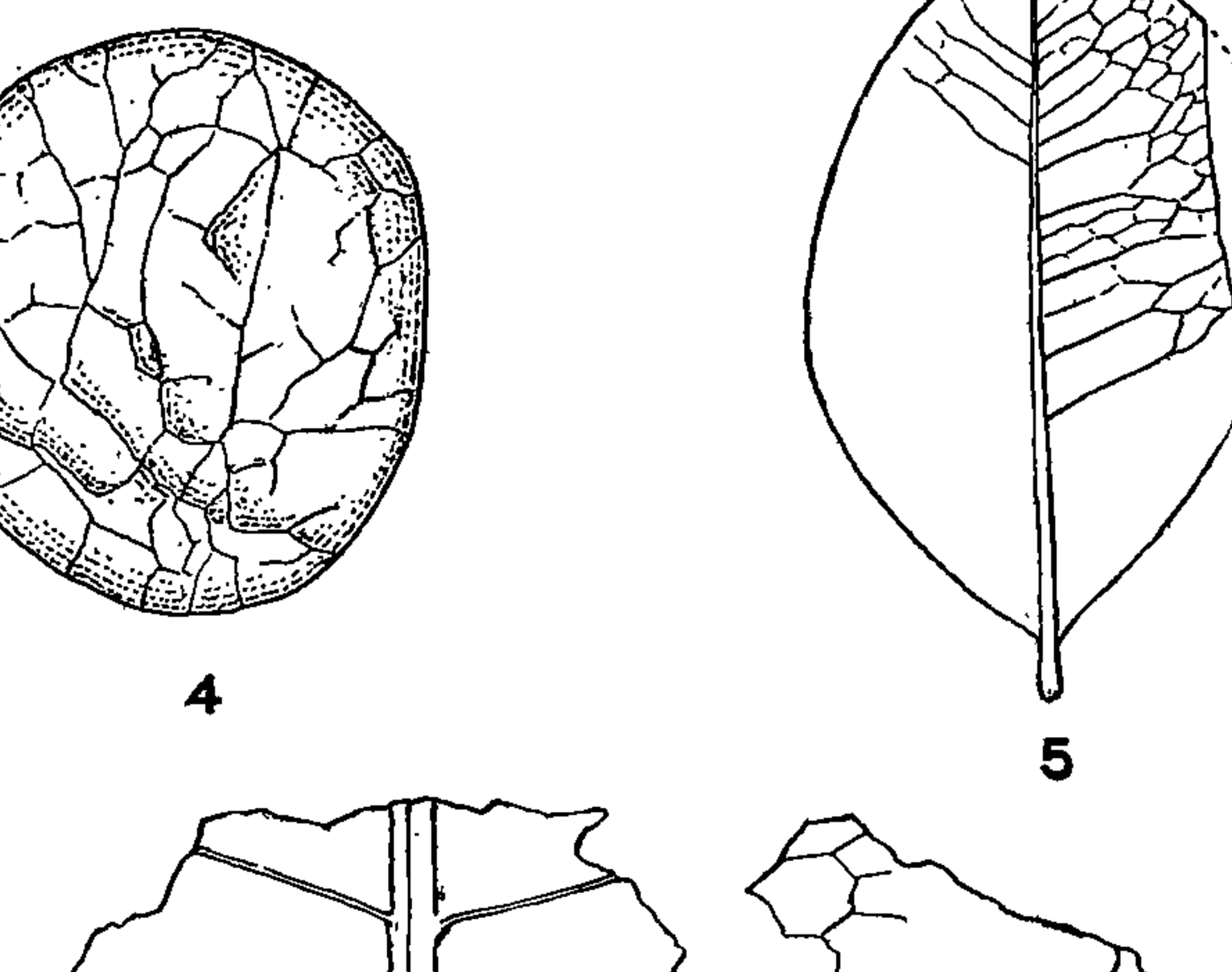


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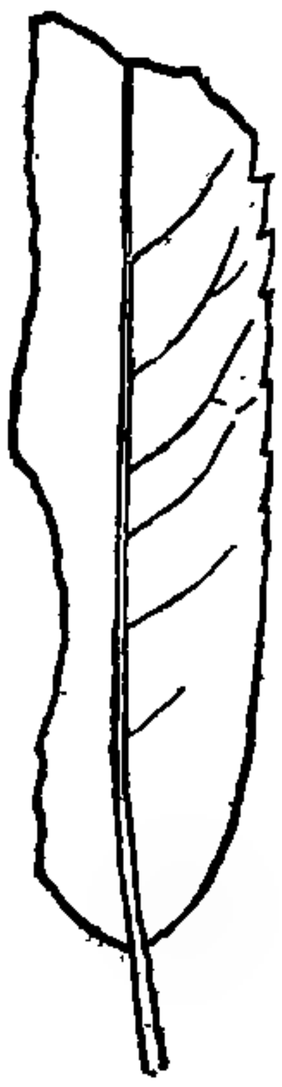
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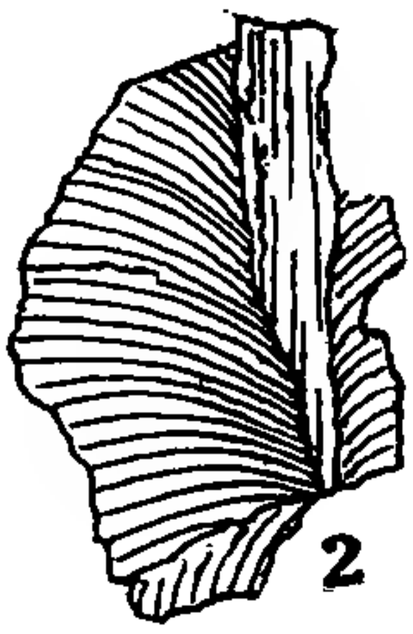
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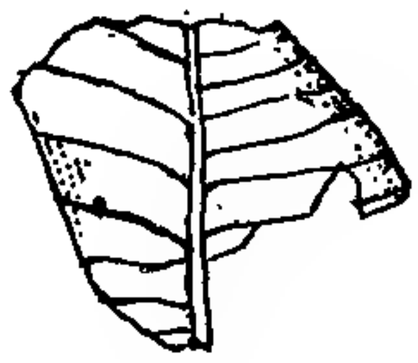
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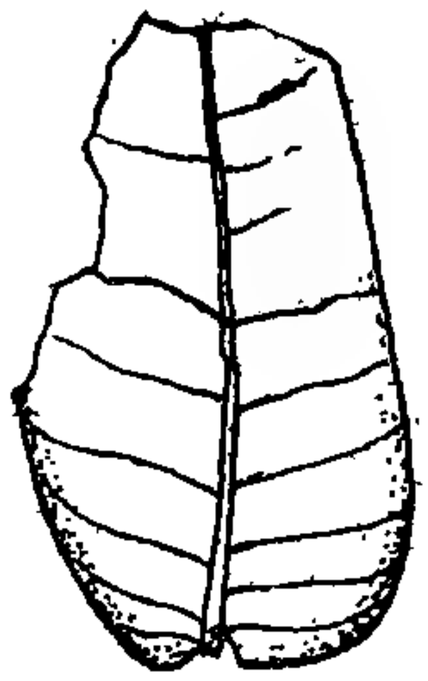
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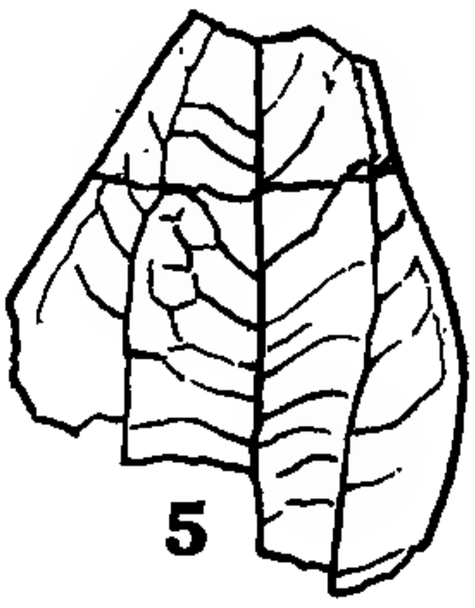
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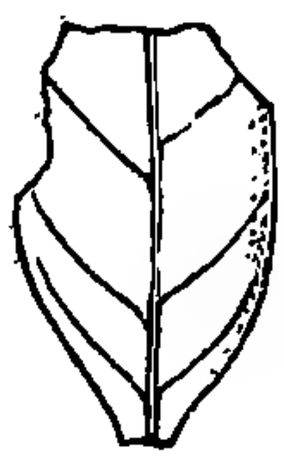
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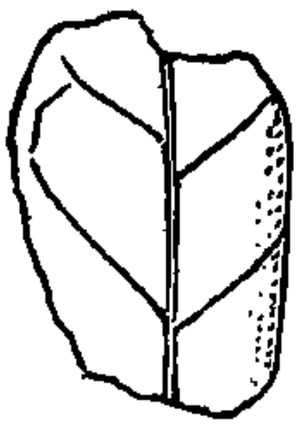
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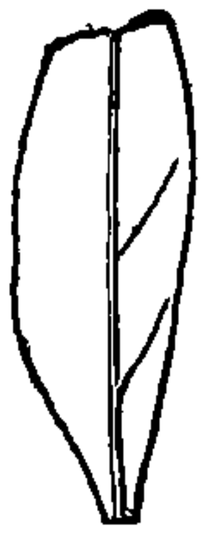
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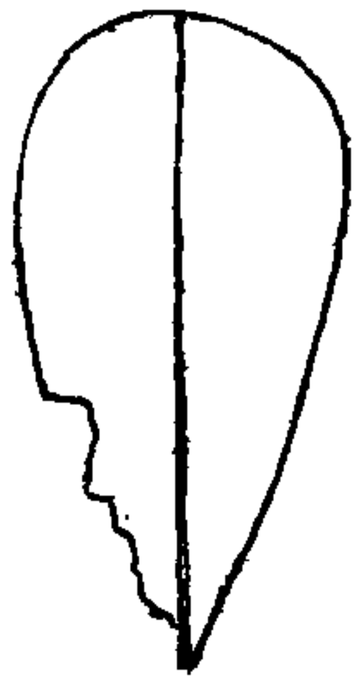
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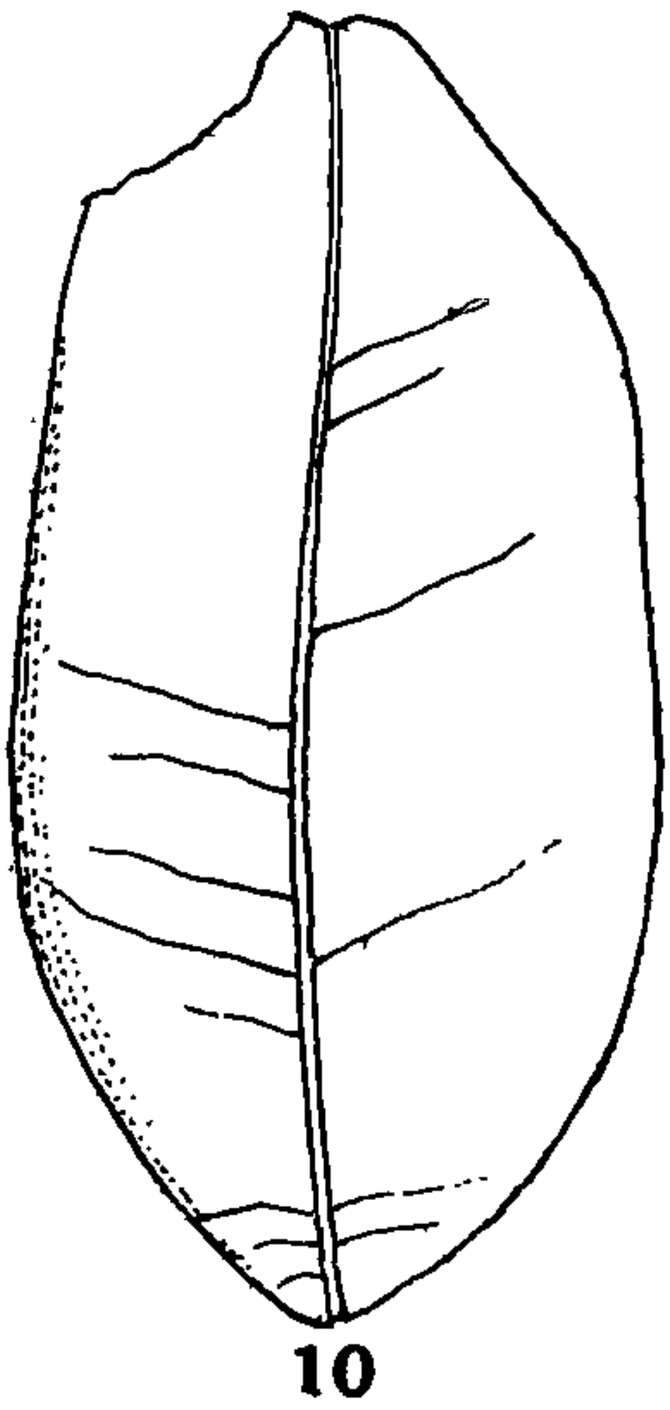
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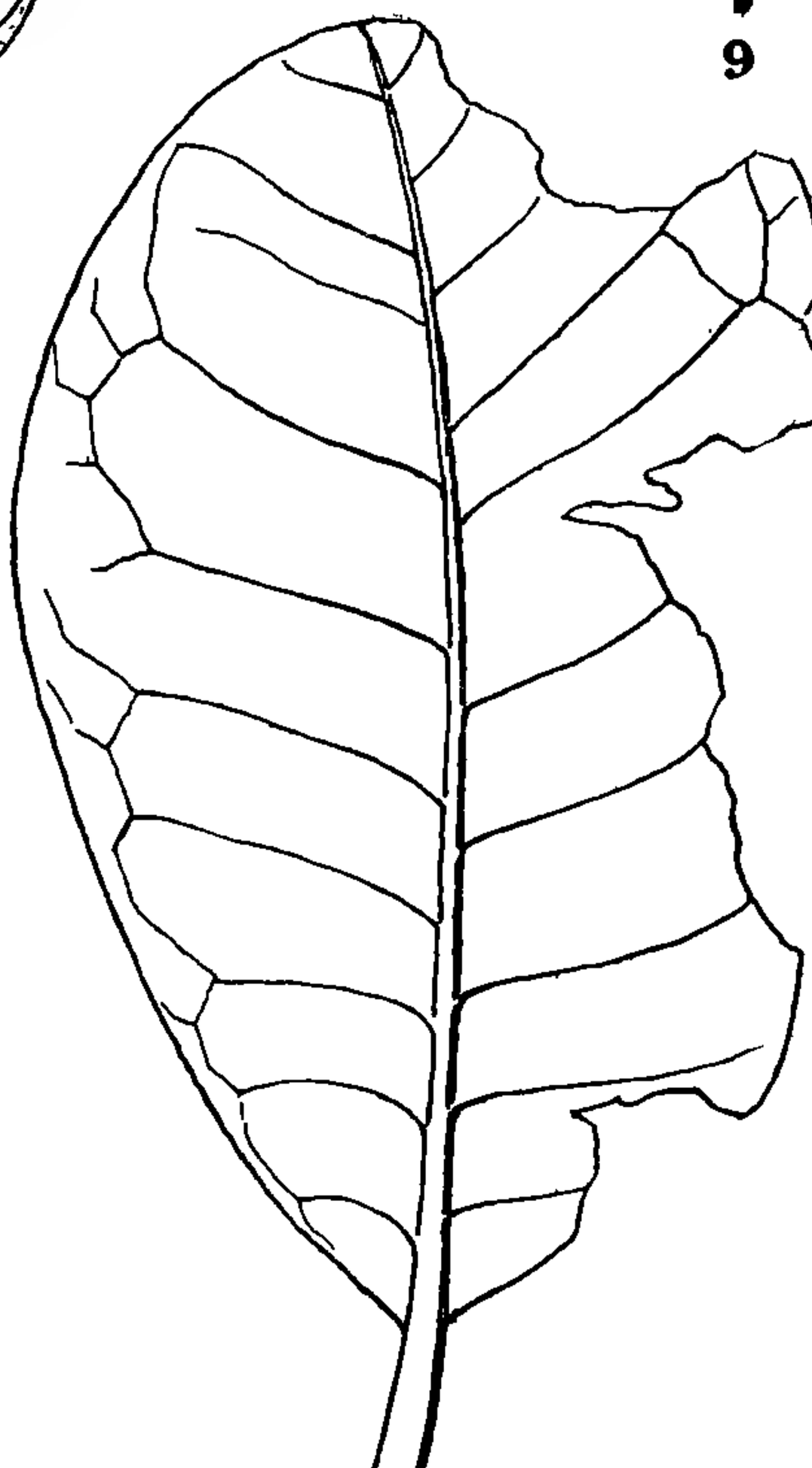
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HOLLICK: FOSSIL FLORA OF THE WEST INDIES (CUBA)

HOLLICK: FOSSIL FLORA OF THE WEST INDIES (CUBA)

Hemlock and Its Environment

I. FIELD RECORDS

By Barrington Moore, Herbert M. Richards, H. A. Gleason, and A. B. Stout [1]

In the spring of 1922 The New York Botanical Garden undertook a study of its hemlock grove and of hemlock forests in general, with a view to determining, so far as possible, the conditions under which hemlock grows and the causes of this isolated hemlock forest on the Botanical Garden grounds. The information would be of value not only in the perpetuation of the hemlock grove but in practical forestry. A fairly comprehensive plan was adopted, calling for field records of climatic conditions, soil investigations, and laboratory experiments under controlled conditions. The work was started, and such instrumental records secured as the limited facilities would permit. It has not yet been possible to commence the soil and laboratory work, although it is hoped that something of a comparatively simple nature may be under way by next winter. Since the field records, though covering but a single season and only a comparatively small number of environmental factors, are yet a more or less complete unit of the larger project, they are presented by themselves as Part I of the hemlock study. We are fully aware of the fact that we have merely scratched the surface of an extremely interesting and important problem, and hope some day, if the facilities become available, to carry the work further.

Purpose of Part I of the Study

The purpose of the first part of the investigation was to find out something of the climatic conditions under which hemlock grows, and the requirements of hemlock for moisture and temperature. It was also desirable to ascertain, if possible, the position of hemlock forests in the developmental series of the types of vegetation which occur in the region. Botanists recognize that

[1] Hemlock Committee of The New York Botanical Garden. The Committee gratefully acknowledges the helpful coöperation of the Yale Forest School, the New York State College of Forestry at Syracuse University, and the Department of Forestry of Cornell University.

the vegetation which occupies the ground today is not necessarily the same as that which has been there in the past or which will be there in the future, if the area is left undisturbed. Vegetation, or associations of plants, like the individual plants, is subject to the laws of evolution. It progresses from lower and simpler to higher and more complex forms. For example, in Eastern United States, a rock ledge in the open will first become covered with drought-resistant lichens. As the rock weathers, and soil is formed, herbs can establish themselves and enrich the soil with their remains. Then come shrubs, and these are followed by drought-resistant trees. Generally these trees are light-demanding species, such as gray birch, juniper, and so forth. Under these trees the more shade-enduring species establish themselves and eventually crowd out the pioneers. The highest type of forest possible in the region is known as the climax forest. Each successive type creates to a certain extent its own environment, and the climax is the richest, and generally the most moist and densest forest which the climate will produce. In drier climates, like the western plain or semi-arid mountains, the climax vegetation is grassland or brush.

In this particular case we would like to know whether the hemlock or the hardwoods represent the climax forest. The hardwoods are the common growth, and formed a large part of the virgin forests of the region when the earlier settlers arrived. But hemlock is more shade-enduring than any of our hardwoods hereabouts, except for beech and sugar maple, and other things being equal, should be able to crowd out the oaks if there were no fire, cutting, or other disturbance. Theoretically, therefore, from standpoint of shade more especially, the hemlock forest appears to be a higher type than the mixed oaks, and to be the climax. If so, the conditions beneath it, the environment which it makes for itself, should be more favorable than that prevailing under the oak forest. Various authorities consider the hemlock as one of the most important constituents of the climax for this region if forest fires are kept out, although they believe it to be a question whether or not pure hemlock is the climax.

Environmental Factors and Instruments

In this study it was not possible to measure all the factors of the environment which we know influence plants. We were

obliged to select for determination certain conditions which would serve as indicators of others. The two most important sets of conditions are moisture and temperature. As an index of moisture we measured evaporation, because in turn evaporation is influenced by factors which influence transpiration, or water loss, by the plant, such as temperature, relative humidity, and wind movement. Of course no instrument which has been or probably ever could be devised would respond to evaporation in the same way that the plant does. On account of the living protoplasm which it contains, the plant, when exposed to unfavorable external factors, sets up internal resistances which we are unable to imitate in our instruments. Evaporation therefore tells us the conditions to which the plant is subjected, not the rate of water loss or of other life processes of the plant. The instruments selected for evaporation were Livingston porous cup atmometers, the evaporating surface being a white sphere of porous porcelain which draws distilled water up from a reservoir bottle to which it is attached by a glass tube. A mercury seal in the tube permits the upward passage of the water, but prevents its downward flow, and thus keeps out rain. The instruments are read by measuring the quantity of water required to refill the reservoir bottle. This gives the total amount of water evaporated, in cubic centimeters, since the last reading, whenever that may have been. In this case readings were made once a week. The instruments are standardized, so that by the application of a correction coefficient the results are comparable with those from similar instruments anywhere else. It might be added that the instrument is widely used in studying plant environments throughout the country, so that the records taken in this investigation can be compared with those for other vegetation in other regions.

In addition to the white spheres, black spheres were used. The black absorbs sunlight to a certain extent, so that the difference between the readings of the black and white spheres gives a rough measure of sunlight, a very important environmental factor. These sunlight, or solar radiation readings were, however, not entirely satisfactory. Under a forest canopy a fleck of sunlight may strike the white sphere while the black is in the shade, and it is impossible to obtain uniform light for both black and white instruments. Hence the white sometimes gives higher readings than the black, an obvious contradiction.

The atmometers were placed so that the spheres were approximately from six to eight inches above the ground. In this way they show the conditions to which the tree seedlings are subjected in becoming established. This is perhaps the most important level under a forest, because the seedlings are the future generation, on which the forest depends for its perpetuation.

As a further measure of moisture, standard Weather Bureau rain gauges were installed in the forest. Tests by Horton [1] have shown that tree crowns intercept considerable amounts of precipitation which is evaporated and never reaches the soil. The proportion varies with the density of the crown and the duration and intensity of the rain. But he has found an average of about 25 per cent for most trees in heavy rains of long duration. In Europe, observations by Matthieu [2] have shown an interception of 5.8 per cent. in winter and 11 per cent. in summer. Reigler [3] found that beech intercepted 21.8 per cent, oak 20.7 per cent, maple 22.5 per cent and spruce 58.8 per cent. It would obviously be extremely interesting to find out how much hemlock intercepts. There are indications that the slow growth of vegetation under a forest is due not only to shade, but also partly at least to lower moisture resulting from the competition of tree roots and from the interception of precipitation by the crowns.

There are certain difficulties in measuring the interception of precipitation by a forest canopy, because the rain which reaches the forest floor is not uniformly distributed. Probably more drips off the end of the branches than comes through the crown, so that a part of the forest floor may receive more than the open, and another part under the crown considerably less. Obviously it would require a large number of rain gauges distributed with reference to the crowns to determine just the amount received by the forest floor. This was impracticable in the present study.

The temperature conditions were measured by taking weekly readings of the maximum and minimum temperature of the air about 8 inches above the ground, and of the soil at depths of 6 inches and 18 inches. Each reading represented the coldest and

[1] Horton, R. E. Rainfall interception. Mon. Weath. Rev. 47: 603–623. 1917.
[2] Matthieu, A. "Metéorologie comparée agricole et forestière," 1878.
[3] Quoted by B. E. Fernow, "Forest Influences." U. S. Dept. Agriculture, Forestry Division, Bull. 7: 131. 1902.

warmest temperatures at these important points during the past week.

Selection of Stations

The selection of stations was made with a view to covering as wide a range of conditions as practical considerations would permit. Thanks to the generous coöperation of the Yale Forest School, the Department of Forestry at Cornell University, and the State College of Forestry at Syracuse, it was possible to secure a distribution of stations which represented fairly well the northern and southern as well as middle portions of the range of the hemlock type. In this particular project we are interested rather in the distribution of hemlock forests than in the range of the tree as a botanical specimen, which, of course, is wider than the range of the forest.

The hemlock grove on the grounds of The New York Botanical Garden represents the most southerly extension of this type of forest along the Atlantic Coast. Accordingly this was taken as the southerly point in the series. It should be pointed out, however, that in all probability the reasons why this grove is the most southerly representative of the type along the coast are not wholly climatic. There seem to be also physiographic causes. South of New York the coastal plain forms a wide belt extending back from the Atlantic ocean. New York is the most southerly point at which the older crystalline rocks come close to the sea. Hemlock is primarily a tree of rocky places and rugged slopes, rather than of deep soils and level stretches such as characterize the coastal plain.

The middle points, or optimum, in the hemlock type were taken at Ithaca and near New Haven. Although New Haven is at about the same latitude as New York, it is distinctly cooler, and is in the midst of thriving hemlock forests which seem to do almost as well as anywhere outside of the well-known stands in Pennsylvania which it was impracticable to include. The northerly point selected was at Cranberry Lake in the Adirondacks, where the tree no longer forms pure stands, but occurs in groups in the predominant northern hardwoods and spruce forest.

Description of Stations

At The New York Botanical Garden the above-mentioned records were taken not only in the midst of the hemlock grove but

at three other stations for comparison. The first station was placed in the open about 300 yards west of the hemlock grove, and about 100 yards north of the Museum building. The aim was to measure the conditions themselves, uninfluenced by the forest. This gives a basis or starting point from which we can tell how the forest has changed conditions. It also represents the environmental factors which the forest must encounter in becoming established.

The second station was in the hemlock grove proper. In order to have it as fairly representative as possible, and avoid local variations due to slopes which cut off the wind and so forth, it was placed approximately on top of the ridge with exposure on all sides, but completely surrounded by hemlock. There is a small proportion of oak scattered through the hemlock forest, and the station happened to be near a white oak. This probably does not appreciably affect the results. There was no undergrowth, and the forest floor was the usual mat of hemlock needles with a sprinkling of oak leaves. There was no young growth of hemlock.

The third station was on the transition line between the hemlock and hardwood types. It was on a gentle slope about 200 yards south of the hemlock station. On one side the forest was predominantly hemlock. The instruments were placed under a mixture of hemlock and beech. There was very little undergrowth, and the forest floor was covered with a thin layer of hemlock needles and beech leaves.

The fourth station was under a typical hardwood forest about 150 yards south of the transition station, on the east side of a low gently sloping ridge. The instruments were beneath the outer crown of a large white oak about 30 inches in diameter at 4½ feet above the ground. There was an understory of dogwood and witch hazel, with a considerable amount of herbaceous undergrowth on the leaf-covered forest floor. There was also a small amount of oak reproduction. The contrast between this light-green deciduous forest with its variety of different species, and the rather sombre pure hemlock such a short distance away was indeed striking.

The hemlock forest on the Botanical Garden grounds is mature, well over 100 years old. While it may be second growth following a former stand which was cut or burned many

years ago, it has never been disturbed except for the removal of dead trees and the trampling of the ground by numerous visitors. This apparently unavoidable trampling, and the absence of mossy logs which form such a favorable seed-bed for hemlock, are probably in large part responsible for the lack of reproduction.

The oak forest seems to be very old, and has the appearance of being a remnant of the virgin forest which clothed the region when the first white men arrived. The trees are, of course, not the same ones, but their direct successors, and are probably well over 100 years old.

For the vicinity of New Haven it was originally planned to have a station in a pure hemlock forest and another under hardwoods. It was finally decided, however, on the recommendation of Prof. Hawley and Dr. Nichols, to have two hemlock stations on markedly different sites, one on a moist north slope, and another on a dry ridge top, in order to determine the actual differences between the extremes for the type. Prof. Hawley and Dr. Nichols are of the opinion that in all probability the climax in general would be a mixed forest of hemlocks and hardwoods, with hemlock commonly predominant and frequently forming pure stands. Certainly the hemlock formerly was much more widely distributed than now; probably it predominated over large areas where today it is absent. An examination of the forest on Saltonstall Ridge, which has been protected from fire by the New Haven Water Company for the past 15 years or so, revealed hemlock reproduction coming up everywhere under the hardwoods. It would seem, therefore, that records under a hardwood forest would merely show conditions in a stage in the successional series leading up to the hemlock climax. Extremes for the hemlock were considered of more interest. Both stations were established on Saltonstall Ridge under forests of pure hemlock. The one on the north slope was young and thrifty, with practically no undergrowth near the instruments, and the usual cover of needles. The soil here was a fairly deep reddish brown glacial till. The ridge top stand was mature, but the trees were short and rather small. The canopy was less dense than on the north slope, and there was a little shrubby and herbaceous undergrowth. The soil was very shallow, and the trap rock which forms the back-bone of the ridge cropped out here and there. Hemlock reproduction was abundant in the openings near both stations.

Cornell established two stations also, one in hemlock and the other in hardwoods. They were about two miles east of the University, just below the general plateau level in a shallow valley. The hemlock station was in a stand of over 90 per cent. hemlock, the trees being from 12 to 24 inches in diameter at 4½ feet above the ground, and averaging 80 feet in height. The only hardwoods, but not right at the station, were an ash and two sugar maples. Around the instruments the forest floor was the usual bare covering of needles, with practically no undergrowth. The hardwood station was about 250 yards away on a moderate slope with a general northerly exposure. The stand was composed principally of fair-sized beech, white oak and sugar maple; there were scattered hemlocks, but not nearer than 100 feet from the instruments. The instruments were placed under a beech tree. A hemlock seedling was found not far from the instruments, and a little scattered hardwood reproduction, with a sparse growth of herbs and shrubs on the leaf mat. It is not unlikely that if protected from fire or other disturbance the hemlock would seed in under the hardwoods and eventually form a considerable if not a preponderant part of the stand. Thus this hardwood forest may be a stage in the successional series leading to the hemlock climax or to a mixture of hemlocks and hardwoods.

The State College of Forestry station was selected with Dr. Bray in a piece of virgin forest on the New York State Forest Preserve near Cranberry Lake in the western Adirondack Mountains. The forest is predominantly a mixture of beech, yellow birch, sugar maple, and red spruce, with only a comparatively small amount of hemlock and an occasional group of magnificent towering old white pines. Some difficulty was experienced in finding a pure hemlock group containing a sufficient number of trees close enough together to form a typical hemlock canopy. Finally, however, a group of half a dozen very large old trees was selected under which the forest floor was very much like that in a typical hemlock forest. It was on a saddle of a small ridge about 200 feet vertically above the lake, and about a quarter of a mile from it.

Records and Interpretation

The New York and New Haven stations were established shortly after the middle of April. The Cranberry Lake station

was set up on May 4, and in digging the holes for the soil thermometers, frozen ground was encountered a few inches below the surface. The Ithaca stations were established May 12. All the stations were read once a week on the same day until October 5, except for the Cranberry Lake station which was discontinued after September 21.

All the records have been plotted on cross-section paper so as to bring out the relations between the different stations graphically. For each environmental factor, all the New York stations were plotted together, but without the other stations, in order to show the relations between conditions in the open, in the hemlock forest, and in the hardwoods. On another set of charts were plotted for each factor, the two New Haven stations, the two Ithaca stations, Cranberry Lake, and the New York hemlock station. All these stations, it will be noticed, were in the hemlock type, except the hardwoods at Ithaca. Therefore this second set of charts should show the environmental relations between examples of the hemlock type in different parts of its range. They should give us a picture of the differences between certain environmental factors in different hemlock forests. With the range of conditions covered we should have some indication of range of requirements of the type. Since the records cover only a single season, it is impossible to say that they represent definite limits, but they do have a distinct relative value, and bring out some rather interesting and unexpected relationships.

The plotting of these two sets of charts for each factor which had to be examined required the plotting of a total of 24 charts, including 120 curves.[1] It will be impossible to reproduce more than a limited number of charts which are typical, or illustrate special features. The detailed records are also too voluminous to publish in full, so only the totals and averages will be presented.[2]

Evaporation

The average daily evaporation for each week from May 12th to October 5th at the four stations on The New York Botanical Garden grounds is shown graphically in figure 1. The relation-

[1] For this laborious and painstaking task thanks are due to Miss Hester M. Rusk of The New York Botanical Garden staff.

[2] The records are on file at The New York Botanical Garden, which will furnish copies to qualified persons at the cost of reproduction.

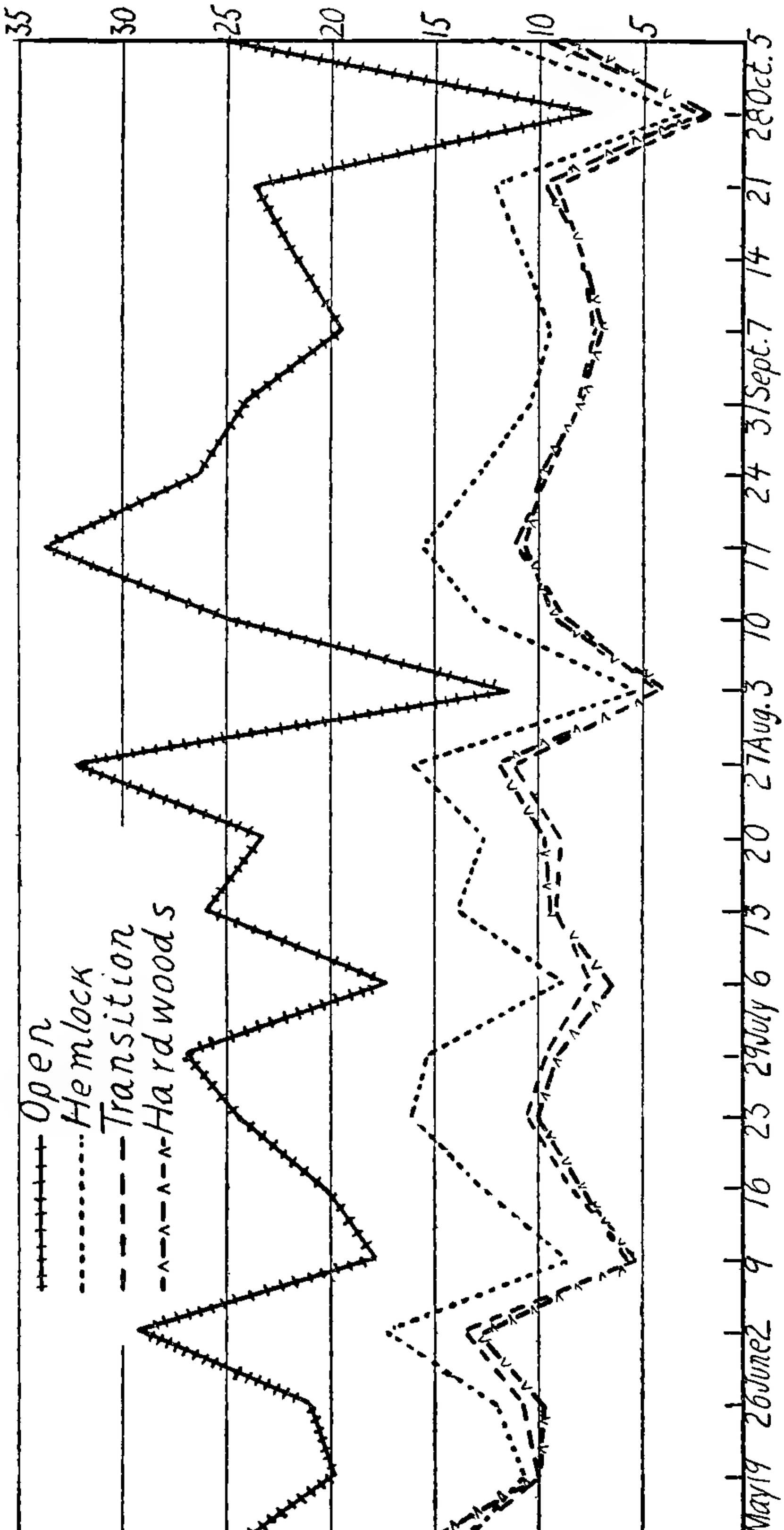


FIGURE I. Average daily evaporation in cubic centimeters, by Livingston white atmometers. New York stations.

ships between the different forest types stand out very clearly, and are consistent throughout the season.

The open station, as would be expected, shows a much higher rate of evaporation than any of the forest stations, and gives a measure of the protection which the forest canopy offers against heavy drains upon moisture. It must be remembered of course that the favorable influence of shelter from forces which raise the transpiration of plants is counterbalanced by the unfavorable effect of shade.

TABLE I.

EVAPORATION, PRECIPITATION, TEMPERATURE, AND SOLAR RADIATION FOR STATIONS INCLUDED IN THE HEMLOCK STUDY, MAY 12 TO SEPTEMBER 21, 1923, INCLUSIVE

Evaporation is the average daily in cubic centimeters for white atmometers; precipitation is the total in inches; temperature the average in degrees F.; solar radiation average daily in c.c.

	Open N. Y. 1	Hemlock N. Y. 2	Transition N. Y. 3	Hardwoods N. Y. 4	N. Haven Ridgetop	N. Haven North Slope	Cranberry Lake	Ithaca Hemlock	Ithaca Hardwoods
Evaporation	23.3	12.2	9.0	8.9	12.0	10.3	7.5	11.8	11.8
Precip. Totals									
Open	10.05	10.05	10.05	10.05	9.09	9.09	11.78	9.00	9.00
Forest Stations		9.16	9.77	10.20	4.64	5.53	7.82	6.18	5.37
Interception		.89	.28		4.35	3.45	3.96	2.82	3.63
Interception %		9%	3%		48%	38%	34%	31%	43%
Temperatures									
Air									
Max.	89.9	85.0	84.7	81.6	80.6	80.1	75.4	81.7	81.7
Min.	49.2	53.1	53.8	53.7	50.1	48.2	37.8	42.3	43.6
Mean	69.5	69.0	69.3	67.7	65.4	63.7	56.6	61.9	62.6
Soil									
Soil 6 in.									
Max.	78.1	66.4	66.7	68.4	65.6	62.6	59.3	62.8	62.5
Min.	62.4	58.7	58.9	59.7	56.8	55.6	47.5	51.4	51.8
Mean	70.3	62.5	62.8	64.0	61.2	59.1	53.4	57.1	57.2
Soil 18 in.									
Max.	67.4	61.9	61.2	62.5	59.5	57.2	51.6	56.1	57.2
Min.	62.6	57.7	56.6	59.1	57.6	53.9	46.9	51.8	52.7
Mean	65.0	59.8	58.9	60.8	58.5	55.5	49.2	54.0	55.0
Solar Radiation	7.4	1.0	0.9	1.1	0.9	0.3	0.36	0.45	0.7

The most interesting and significant feature of the chart is that it shows the evaporation under the hemlock forest to be distinctly

and consistently higher than that under the hardwoods throughout the entire season. So far as evaporation is concerned—and it is a pretty fair index of moisture—the hemlock type is drier than the mixed oaks. This is contrary to all expectations, and its bearing on our conception of developmental trends in vegetation will be discussed more fully below.

The Ithaca hemlock and hardwoods, we see from Table I, had exactly the same average daily evaporation for the season, so that they neither corroborate nor contradict the New York results. But the hemlock at Ithaca was consistently a little higher than the hardwoods for an uninterrupted period extending from June 2 to August 24, or the longest and most important part of the growing season. Furthermore, in describing the stations we hinted that this particular piece of hardwoods may possibly be merely a stage in a successional series leading to the hemlock type or to a stand with a considerable proportion of hemlock in mixture.

The explanation of the higher evaporation under hemlock as compared with hardwoods is probably to be found in the practically bare needle-covered forest floor of the hemlock which, in spite of its shadiness, is rather dry. Under the oak type, the shrubby and herbaceous vegetation may lower the rate of evaporation by checking the circulation of air, and also by raising the relative humidity through the moisture they give off as transpiration. Measurements of the relative humidity would be needed to determine this point.

The hardwood forest and transition between hardwoods and hemlock have nearly the same rate of evaporation, the curves almost coinciding throughout (See FIGURE 1). At the end of the season the transition averaged only .1 c.c. per day higher than the hardwoods. This amount is too small to warrant consideration: but is in agreement with the higher rate for hemlock.

The average daily evaporation for all stations, given in Table I, shows that, aside from Cranberry Lake, the evaporation under hemlock forests is almost the same, even when the forests are hundreds of miles apart. The markedly lower evaporation at Cranberry Lake is to be expected because of the northerly location of the station. The difference between the evaporation under the New York hemlock and the New Haven ridge top station is only .2 c.c. per day. The fact that New Haven is a

trifle lower than New York in spite of its drier appearance, is probably accounted for by the slightly lower air temperature. The evaporation at the Ithaca hemlock station was only .2 c.c. lower than the New Haven ridge top, possibly accounted for by being a little cooler, and only .4 c.c lower than New York.

The similarity between the evaporation in widely separated hemlock forests is rendered all the more striking by the small difference between such extreme examples of the type as the two stations on Saltonstall Ridge near New Haven. The ridge top was about as dry looking a hemlock site as one could find, while the north slope was moist and obviously favorable. In fact, as noted above, the stations were selected to bring out the contrasts between dry and moist hemlock forests. Yet the difference between the rate of evaporation under the two sites was only 1.7 c.c. per day for the season. Expressed in terms of percentages, the evaporation on the favorable site was only 14 per cent lower than that on the dry site. In terms of New York hemlock as 100, the New Haven ridge top was 98, and the north slope 84. Thus, excluding Cranberry Lake for the moment, the total range between extreme hemlock sites about 300 miles apart was only 1.9 c.c. per day, or 16 per cent. Yet the difference between the hemlock and hardwood forests on the New York Botanical Garden grounds about the same number of yards apart was 3.3 c.c. per day, or 29 per cent.

Even when Cranberry Lake is included, the difference in rate of evaporation between the extreme north and south examples of hemlock is only 4.7 c.c. per day. In terms of New York as 100, Cranberry Lake is 62.

The natural tendency would be to discount a considerable part of these results on the ground of their covering only a single season, if it were not for similar work on Mt. Desert Island, Maine, covering three seasons representing extremely dry and unusually wet summers. The Mt. Desert results showed that the relations between the forest types remained nearly the same throughout the different seasons. The actual amount of evaporation was different, though not very much so in the two dry years, but the percentage relations of the forest types held consistently. For example, the evaporation at the spruce station during the three years, expressed in terms of the pitch pine forest as 100, was 28, 24 and 29. The middle number

represents the moist year. The differences in evaporation between different forest types on Mt. Desert Island less than 4 miles apart, were very much greater than the differences in evaporation in the hemlock type, even including Cranberry Lake. For example, taking white pine and spruce, both with complete forest canopies casting practically full shade similar to hemlock; white pine was 11.6 as against 4.0 for spruce in the wet year, and 17.4 as against 7.0 for spruce in the dry year. Compare these figures with a range of only from 12.2 to 7.5 for hemlock at The New York Botanical Garden and the Adirondack Mountains. Furthermore, it is of more than passing interest that the hemlock evaporation, taking the stations as a whole, fits remarkably well into the Mt. Desert island series, being distinctly higher than spruce and lower than white pine, just as we would expect.

The similarity between the different hemlock stations shows not only in the seasonal averages, but on the chart of weekly evaporation. Cranberry Lake stands out on account of being the lowest, but the others criss-cross inextricably. We can perhaps get some of the relationships by counting the number of times (weekly readings) each station was the highest of all.

The chart covers 22 weeks, from May 12 to October 5 inclusive. Cranberry Lake does not begin till May 19 and ends September 21, but this does not affect the following figures. The New Haven ridge top was highest 6 out of the 22 weeks, Ithaca was highest 5 times, New York 4 times, and Cranberry Lake twice. During the other 4 weeks the Ithaca hardwoods were highest. The north slope at New Haven was never highest. This gives an indication of how the curves cross and re-cross. The averages given in Table I represent conditions fairly well.

Precipitation

The total precipitation at each station from May 12 to September 21 is given in Table I. The charts of precipitation need not be reproduced. The curves for the stations outside of New York, and New York hemlock, across and recross owing to the different time at which the precipitation occurs. The New York curves run along close together.

We were fortunate in being able to secure figures for the precipitation in the open near the other stations as well as at New York. For the New Haven stations the Water Company has a

rain gauge near Saltonstall ridge, the records of which were kindly supplied by Mr. Leonard M. Tarr of the Weather Bureau. For Ithaca, Mr. W. M. Wilson kindly furnished us with records for a station two miles east of Ithaca, and therefore rather near to the Cornell stations. These gauges nearer our stations gave slightly higher readings than the ones of the Weather Bureau in the towns of Ithaca and New Haven.

The amounts of precipitation in the open have been inserted in Table I, and from them the amounts under the forest subtracted. The differences represent the net interception by the forest canopy for the particular spots where the rain gauges were placed. The weekly records, which are not reproduced in this report, show that some of the readings under the forest were actually higher than in the open. This happened with 19 of the readings at the New York stations, where we fortunately have daily as well as weekly records. It also occurred occasionally at New Haven. These higher readings under the forest must have been due for the most part to dripping from the ends of the branches which may have been more pronounced under some conditions than under others.

Except at the New York stations, the net interception was considerable, running from 31 per cent at the Ithaca hemlock to 48 per cent. for the New Haven ridge top, or from nearly a third to nearly a half. At New Haven the north slope interception is decreased by two periods during which the gauge at this station showed considerably more than in the open. If the excess for the north slope station in these periods were eliminated, the interception would be 47 per cent, or practically the same as the ridge top. At New York, even if we eliminated the amounts in excess of the open readings, the interception would still be small, only 13 per cent. for hemlock, 11 per cent. for the transition and 6 per cent. for the hardwoods. Just why interception at the New York stations is so much less than at the others is not clear, unless the gauges at all three of these stations were nearer the edge of the crowns than at the five other stations. This hardly seems probable. It may be that the character of the precipitation, in particular the prevalence of short heavy showers near New York, has something to do with the lower interception here.

Temperature

The temperature readings for the season at all stations have been averaged, and the results are presented in Table I. The weekly records themselves are too voluminous to include.[1] In order to bring out the relationships between the stations, which could not be found without a great deal of poring over the figures, some of the values are shown graphically in FIGURES 2 to 4.

It is impracticable to reproduce all of the 18 charts which were plotted to compare the weekly readings of the different stations throughout the season. Three charts, the mean soil temperature at 6 inches for the New York stations, the mean soil temperature at 6 inches for the coöperating stations and New York hemlock, and the mean soil temperature at 18 inches for the other stations and New York hemlock, are shown as FIGURES 2 to 4 In general, the charts on which the New York stations alone appear are clear and have comparatively little crossing of the lines. The mean 6-inch soil temperature for the New York stations, FIGURE 2, is a good example. With the other stations and New York hemlock there is a good deal of crossing back and forth, making it difficult to follow out the different stations. The 6-inch mean soil temperature for all coöperating stations and New York, FIGURE 3, is a fair example of this. As would be expected, the criss-crossing is most with the air temperatures, and least at 18 inches in the soil.

The air temperature records show, among other things, the influence of the forest canopy in moderating extremes. On the maximum chart the open station was consistently highest throughout, and on the minimum chart it was consistently the lowest. The higher maxima and lower minima at the open station offset each other, so that the mean temperature for the season was only very slightly above that under the forest. This illustrates the importance of obtaining maximum and minimum readings in studies of plant habitats. In this case the mean fails to show the severer temperature stresses to which the plants are subjected in the open as compared with those under the shelter of the forest.

The maximum air temperatures at New York show that the hemlock forest was noticeably and consistently warmer than the

[1] As with the evaporation records (see footnote 6), copies can be obtained by qualified persons at the cost of reproducing.

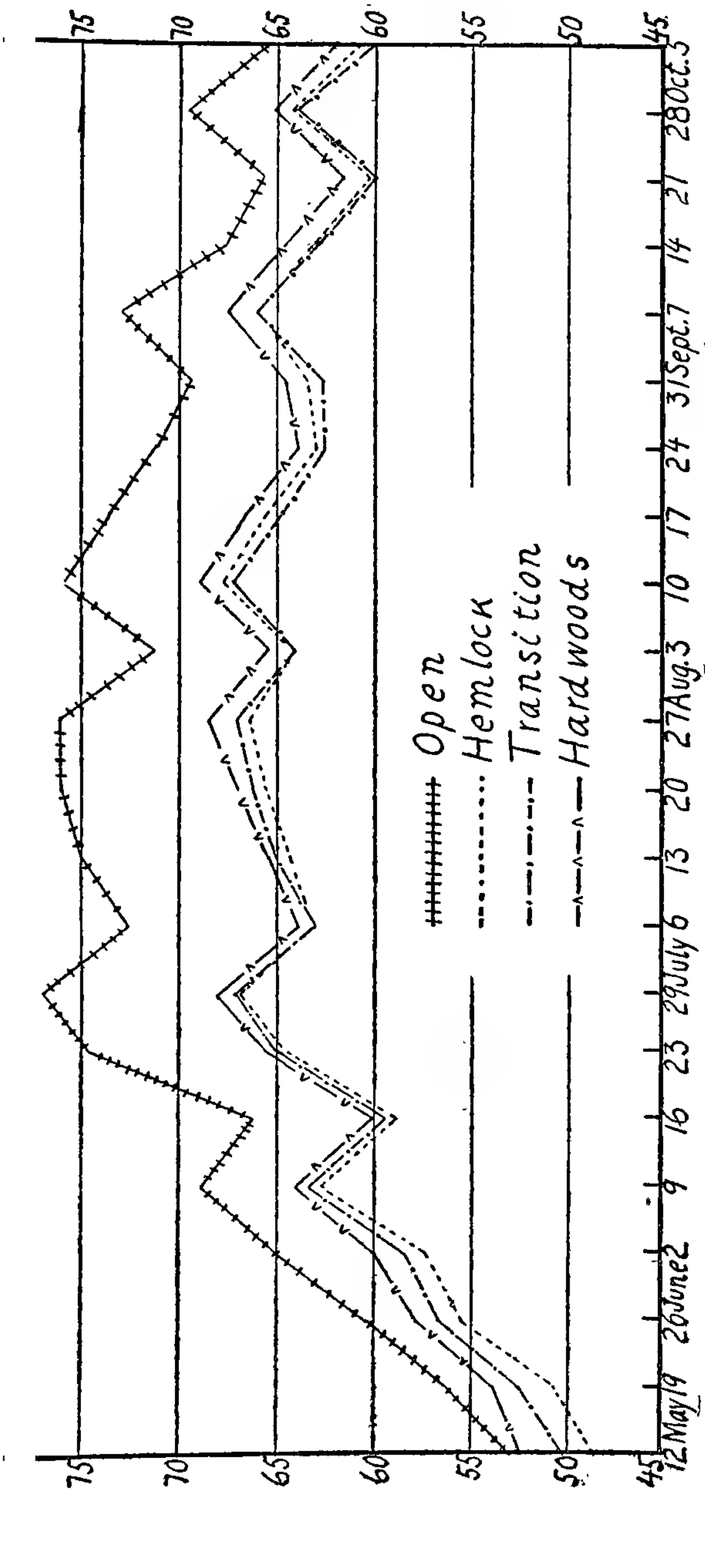


FIGURE 2. Mean soil temperature (degrees F.) at six inches. New York stations.

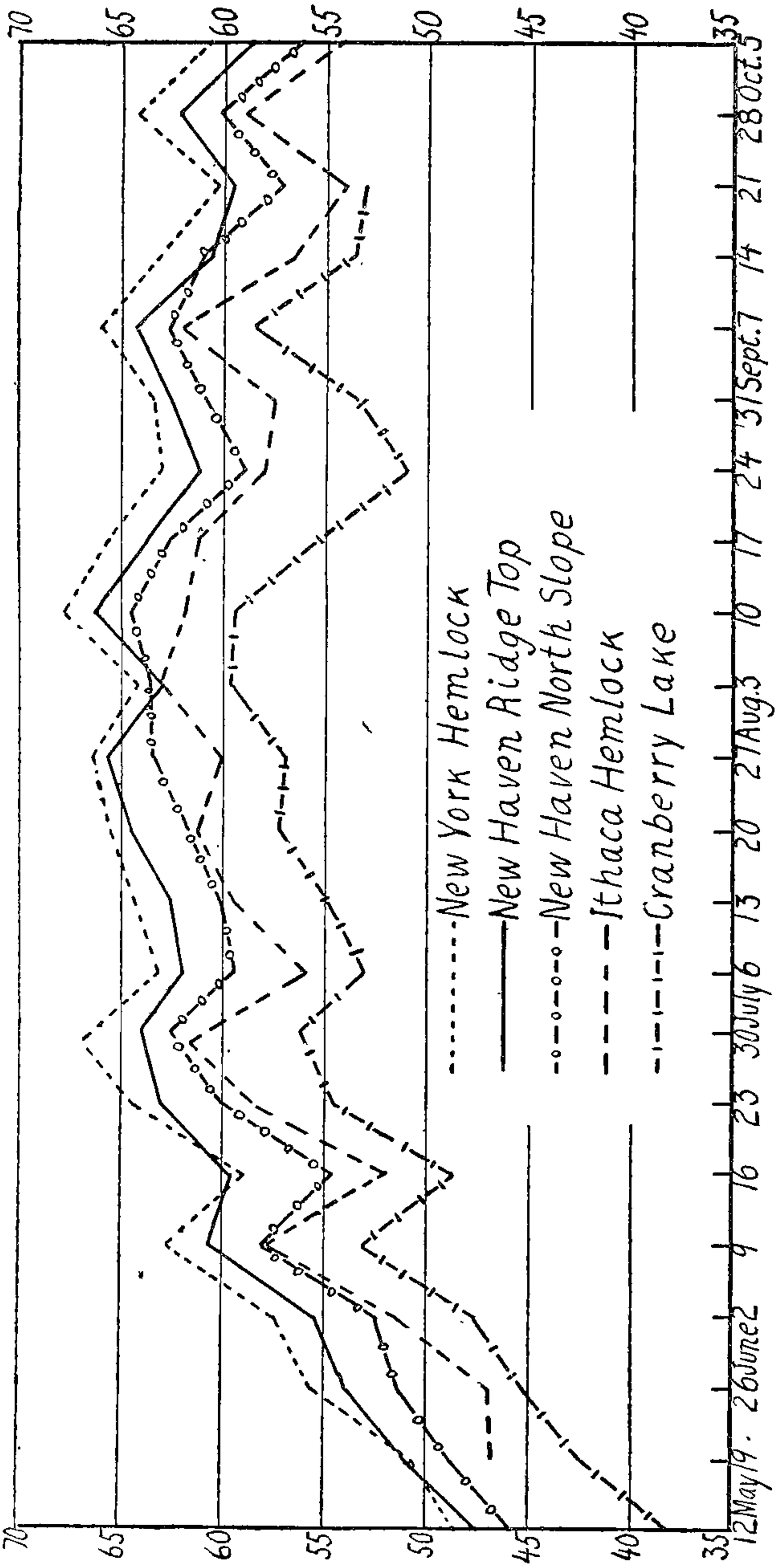


FIGURE 3. Mean soil temperature at six inches. All hemlock stations.

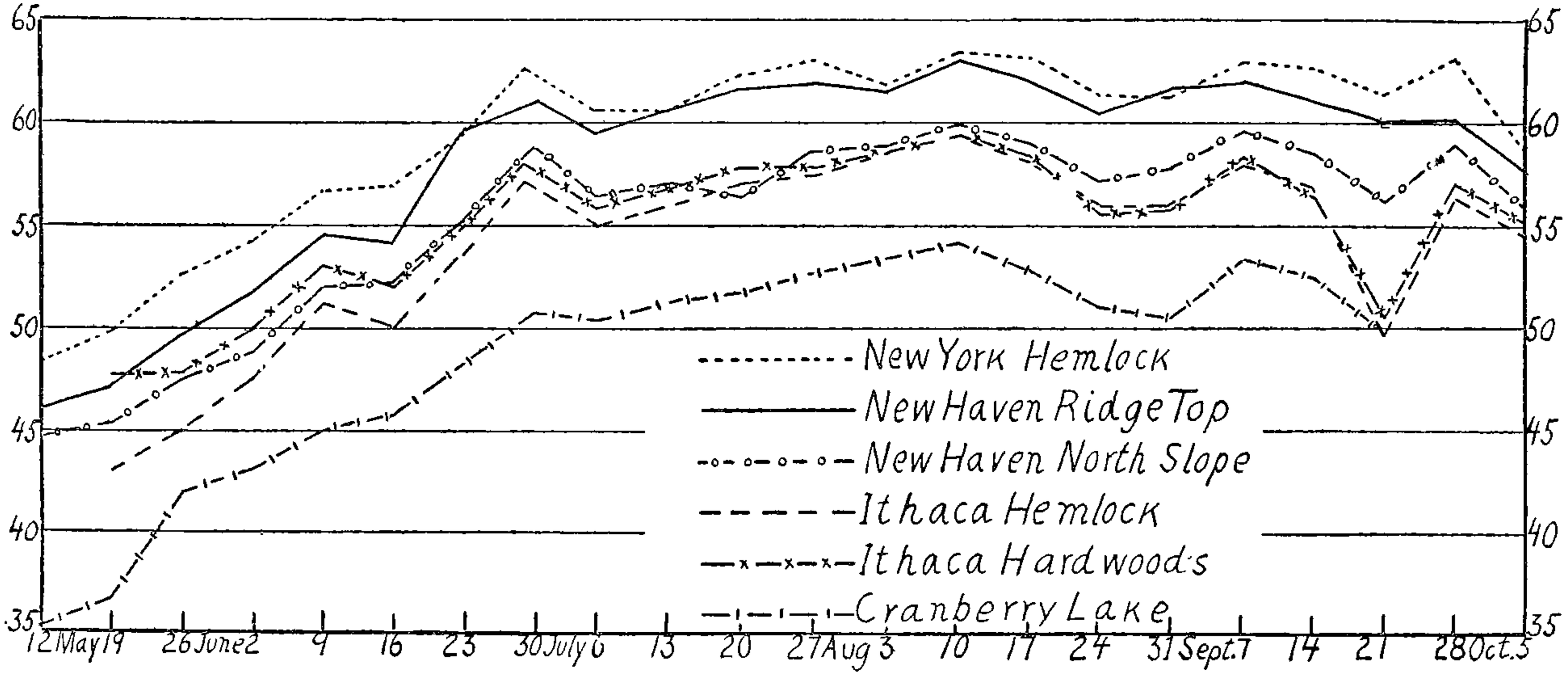


FIGURE 4. Mean soil temperature at eighteen inches. All hemlock stations and Ithaca hardwoods.

hardwoods from May 26 to September 14 inclusive. The transition forest closely resembled the hemlock in this respect, although with respect to evaporation we have seen that it was more like the hardwoods. In minimum temperatures there seems to have been little difference between the New York forest stations,[1] although the hemlock was slightly colder than the hardwoods. Therefore, in the means the hemlock remains warmer than the hardwoods.

The air temperature in the hemlock forests near New Haven was distinctly cooler than in any of the forests at New York. The north slope had a slightly lower maximum than the ridge top, and a distinctly lower mimimum, resulting in a lower mean.

The Ithaca stations show the influence of their greater distance from the moderating influence of the sea. Both stations have higher maximum air temperatures than New Haven, but considerably lower minima. These greater extremes average up somewhat in the means, but still leave Ithaca colder than New Haven.

Cranberry Lake, as would be expected, is the coldest station in all respects. Its continental climate is shown by the greater spread between its average maximum and average minimum as compared with New York, amounting to 37.6° F. against 21.9° for the New York hemlock. In this respect it is slightly exceeded by the Ithaca stations, which showed spreads of 39.4° and 38.4° for the hemlock and hard woods respectively.

In soil temperature both at 6 and 18 inches the relation between hemlock and hard-wood is the reverse of the above noted for air temperature. The soil under the hardwoods is warmer than it is under the hemlock. This is in accordance with what we would expect from the geographic distribution of the two types. The apparent contradiction with air temperature is probably explained by the fact that, while the maxima under the hemlock are higher than under the hardwoods, the hemlock minima are slightly lower. The maxima may come from higher temperatures which

[1] The minimum thermometers used for air temperatures at New York gave a good deal of trouble with breaking up of the spirit column, after the first part of August. This has necessitated interpolating a number of the New York minimum air temperature readings. The interpolations were made on the curves, with the trends of the other stations and past readings as a guide, and it is thought do not involve serious errors. In any case they do not affect the relative position of the stations, or the conclusions.

last for only brief periods, not long enough to warm up the soil. This goes to indicate that the temperature conditions under the hardwood, with their slightly warmer soil and slightly cooler air, and with less spread between the maxima and minima, are a little more favorable than under the hemlocks. In addition, the moisture under hardwoods is more favorable on account of the lower evaporation.

The relation between the hemlock and hardwoods at Ithaca with respect to the 18 inch soil temperature is the same as at New York. At 6 inches the differences between the two Ithaca stations are extremely small.

At New Haven, the ridge top hemlock forest was warmer in all respects than that growing on the north slope. In soil temperature at both depths, as with mean air temperature, the New Haven stations were intermediate between New York and Ithaca. It is interesting that at 18 inches all the figures, and at 6 inches the maxima, show the ridge top to be closer to New York, and north slope closer to Ithaca. Thus the difference in site tends to bring about differences in certain environmental factors resembling differences produced by considerable distances. This is merely another example, on a much smaller scale, of the well-known site differences between north slopes and south slopes which occur in the mountains of the southwest.

Considering the New York hemlock grove as roughly approximating the southern point in the range of the hemlock type, and Cranberry Lake the northern point, the temperature figures in Table I give an indication of the temperature range of the type for the growing season. For convenience these figures have been brought together in Table II, to which has been added the number of degrees of spread in the range.

A glance at Table II shows that the range of temperatures covered by the hemlock type is not large, 12° for mean air temperature, 10° for mean soil temperature at 6 inches, and 11° for mean soil temperature at 18 inches. It is possible that more widely separated stations would extend this range somewhat, but probably not very much.

Fortunately we have a comparison for the northern limit. On Mt. Desert Island, Maine, soil temperatures were taken at the same levels in the same manner under a series of forest types. The coldest of the series was a spruce type distinctly more

TABLE II

APPROXIMATE TEMPERATURE LIMITS OF THE HEMLOCK TYPE, BASED ON RANGE BETWEEN NEW YORK AND CRANBERRY LAKE. IN DEGREES F.

	South (N. Y.)	North (Cran. Lake)	Range
Air Temperature			
Maximum	85	75	10
Minimum	53	38	15
Mean	69	57	12
6-inch Soil Temperature			
Maximum	66	59	7
Minimum	59	48	11
Mean	63	53	10
18-inch Soil Temperature			
Maximum	62	52	10
Minimum	58	47	11
Mean	60	49	11

northern in its affinities than the hemlock at Cranberry Lake, and growing not far from the crowberry (*Empetrum nigrum*), an arctic-alpine plant which here comes down to sea-level because of the cold waters. The Cranberry Lake 6-inch mean, when reduced to the same period as that covered by the Mt. Desert records (June 9 to September 21) was 56.1° as compared with 55.5 for Mt. Desert, and the 18-inch mean was 51.8 as against 51.2 for Maine. Thus for the same period the Cranberry Lake hemlock soil was only .6° warmer at both 6 and 18 inches than the soil at the same depths under a spruce type on a markedly cold situation. It is, therefore, reasonable to consider that the conditions at Cranberry Lake approach pretty closely to those at the northern extension of hemlock.

We have no similar comparisons to check the southern limit, but it is not likely that hemlock forests inland further to the south would be much warmer than at New York.

On the whole, the temperature differences between the different stations, like evaporation, are remarkably small, especially when we consider the general climatic differences between New York and the Adirondack Mountains.

The narrow range of temperature limits found in this study seem to indicate that comparatively small differences in temperature may be of considerable importance to vegetation. There were similar indications in a study of different forest types on

Mount Desert Island, Maine. This does not, of course, in any way detract from the importance of the moisture relations.

Solar Radiation

As already explained in the section on instruments, the difference between the readings of the black and white atmometers does not give a wholly satisfactory measure of the light conditions under the forest canopy. When the values were plotted, the curves, except of course for the open station, crossed and recrossed in apparently hopeless confusion. Yet when the records were averaged for the whole season, the rate per day seems to correspond in a general way with the density of the forest canopy. For the New York stations the hardwoods are a little higher, and the canopy is slightly less dense, as shown by the richer undervegetation. But all the New York forest stations are very much alike in respect to crown cover, and the solar radiation values run close together. The New Haven ridge top gives about the same value as the New York stations, though we would have expected it to be a little higher since the stand seems to be a little more open. The north slope shows a much lower solar radiation value than the ridge top, which agrees with its denser shade. The lower value for the Ithaca hemlock as compared with the hardwoods agrees with the denser canopy. The Cranberry Lake station was in a very shady spot, and shows a correspondingly low value.

Position of the Hemlock Type in the Successional Series

The records show that the hardwoods, so far as evaporation is concerned, are moister than a forest of pure hemlock. It is true that records in other hardwood stands might show a higher rate of evaporation, but this could not be determined one way or the other without a considerable number of additional stations. For the present we will have to take the results we have, recognizing that they are tentative, although supported by indications from another study. There has been a common tendency to consider moisture as the criterion of the climax forest, the climax representing the highest degree of moisture. Nichols, however, considers that the climax is not necessarily any more moist than certain other stages, and that exactly the opposite may be true. "Ecological advance," or in common parlance the stage of progress,

"as determined by various factors, which may be quite different in different successional series, should be the criterion." If shade is the critical factor, the climax might well be less moist than a preceding stage.[1]

The hemlock type well illustrates the above conception. Hemlock can stand much more shade than the oaks; hence when protected from fire, it is able to survive under their crowns and eventually come up and crowd them out. Two hardwoods only, beech and sugar maple,[2] are more tolerant of shade than hemlock, but are less abundant around here than the oaks. It is reasonable, therefore, to consider hemlock as the climax forest.

Since hardwoods make up the climax forest further south, and hemlock is the climax to the east and north of New York City, it has been suggested that perhaps we have on the Botanical Garden grounds two climax forests existing side by side.

Whatever may be the cause, the two types have not mixed appreciably in the long period that they have lived in contact with each other, with every opportunity for the mutual interchange of seed and for either to invade the other.

The climatic differences which the above records show between the two types of forest do not seem sufficient to account for the distinctness of the two, unless the hemlock grove is at the absolute limit of the warmth which this type of forest will endure. If this were the case, any increase of temperature would prevent the establishment of hemlock. But the soil temperatures in the hardwoods had a maximum of only 2° F. higher at 6 inches, and only .6° higher at 18 inches, which seems so small as to require a dividing line much sharper than appears reasonable. It will be necessary to look elsewhere for the cause of the difference, and soil conditions appear to offer the most promising line of attack.

SUMMARY

Representative examples of hemlock forests, and two examples of hardwoods, were selected to cover roughly the north and south range of the hemlock type. The southerly representative was

[1] Nichols, G. E. "A Working Basis for the Ecological Classification of Plant Communities." Ecology, 4: 11–23; 154–179. 1923. The quotation is from a letter written by Dr. Nichols about this particular study.

[2] Burns, George P. "Minimum Light Requirements Referred to a Definite Standard." Vermont Agr. Exp. Sta. Bull. 235, 1923.

the hemlock grove on the grounds of the New York Botanical Garden, in addition to which stations were established in an adjoining mature hardwood forest, in the transition between hemlock and hardwoods and in the open. With the coöperation of Yale University, Cornell University, and the State College of Forestry at Syracuse, two stations were established near New Haven representing favorable and unfavorable hemlock sites, two at Ithaca representing a hemlock and a hardwood type, and one at Cranberry Lake in the Adirondack Mountains under a group of hemlock in the northern hardwood and spruce forest.

At each station weekly readings were taken during the summer of 1923, covering evaporation (with Livingston atmometers), solar radiation (black and white atmometers), precipitation, and maximum and minimum temperature of the air and of the soil at 6 and at 18 inches depth.

The evaporation under hemlock was higher than that under hardwoods, 12.2 c.c. per day as against 8.9 c.c.

The evaporation under the five hemlock stations was very similar. It was, in c.c. per day, New York, 12.2; New Haven ridge top 12.0, New Haven north slope 10.3, Ithaca 11.8, and Cranberry Lake 7.5

The difference in evaporation between extreme hemlock sites near New Haven was less than the difference between hemlock and hardwoods at New York; only 1.7 c.c. as against 3.3 c.c. Hemlock forests 300 miles apart have a closer resemblance with respect to evaporation than hemlock and hardwoods 300 yards apart.

The rate of evaporation under hemlock is intermediate between that found for spruce, 7.0, and for white pine, 17.4, on Mt. Desert Island, Maine, during approximately the same period.

The air temperature under hemlock had a higher maximum and mean, but a slightly lower minimum than under the hardwoods.

The soil temperature under hemlock at both 6 and 18 inches is colder than under hardwoods.

The extreme range of temperature between the north and south limits of hemlock included in this study is small: 12° F. for the mean air temperature, 10° for the mean soil temperature at 6 inches, and 11° for the same at 18 inches.

The stations probably include the coldest growing season conditions at which the hemlock type can occur naturally. The

Cranberry Lake mean soil temperatures at 6 and 18 inches were only .6° higher than temperatures at the same depths for the same period under a distinctly cold spruce forest on Mt. Desert Island, Maine.

The comparatively small range in temperature appears to indicate that small differences in temperature may be of considerable importance to vegetation.

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